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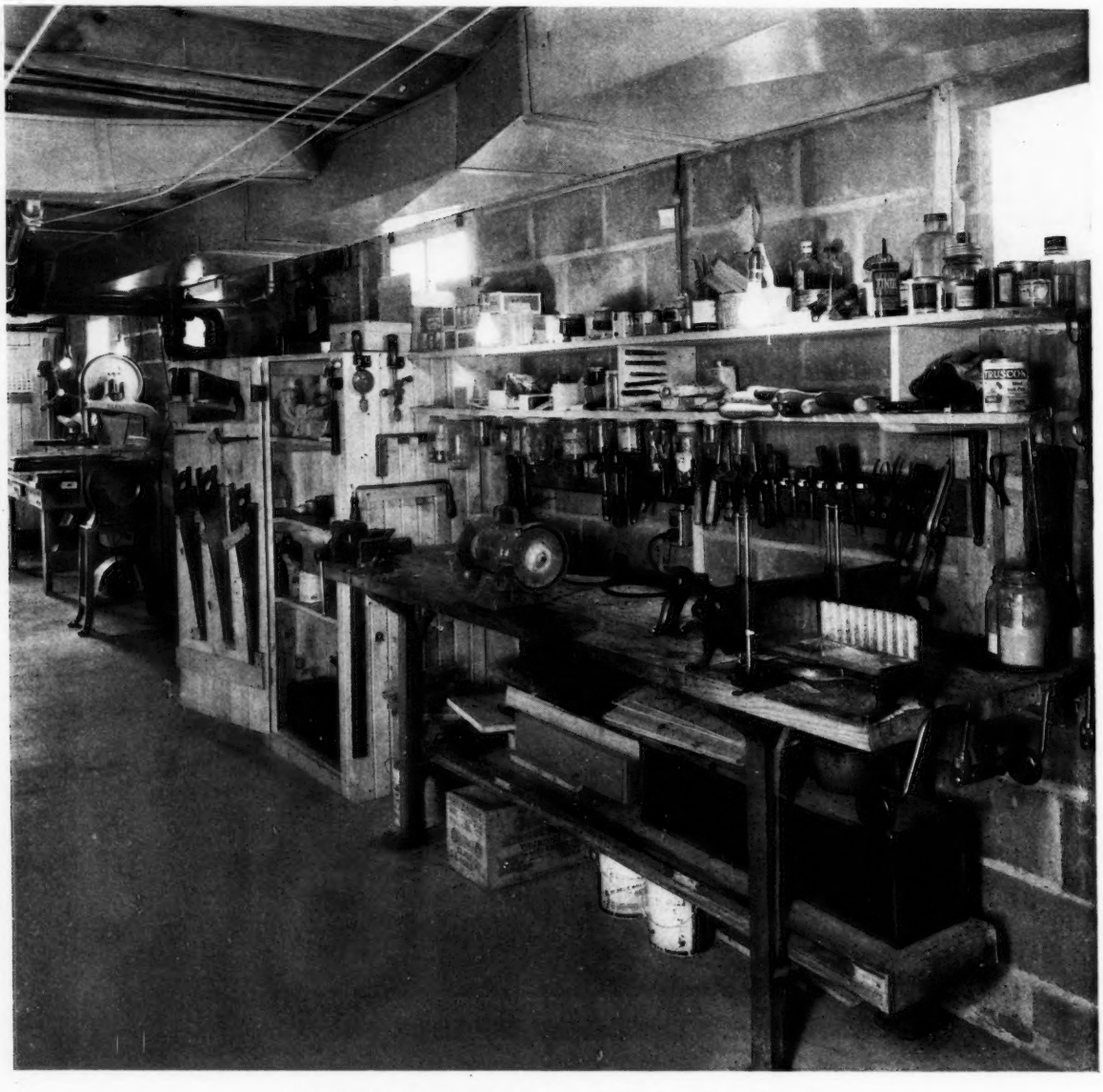

ENGINEERED FARM SHOPS

MOST farmers have a claw hammer and a crosscut saw around the place as a matter of course. Some few go to the opposite extreme of accumulating farm shop equipment and spending time with it to the neglect of their regular farming equipment and operations. Somewhere between these two extremes is a mean of farm shop development and use which may be a definite aid to low-cost production, satisfactory farm living, and to holding and developing the interest and abilities of farm boys.

As secondary tooling for effective farming the farm shop might logically be engineered to make the most of opportunities for profitable use of time. How far a farmer may logically go in investing in shop space and equipment will depend on a number of considerations, notably the type and scale of his farming operations, local availability and cost of satisfactory commercial shop service, his aptitude for shop work, time available for shop work without detriment to the primary farm operating program, and personal values and satisfactions which might be obtained from use of the shop.

These considerations suggest something more, by way of agricultural engineering help in the development of farm shops, than general instructions on selection, care, and use of equipment; or organization of the shop for comfort, convenience, good lighting, safety, and effective work, important as such items may be. They suggest analysis of needs, statements of principles, sample schedules, estimates of normal time requirements, and indications of the relative simplicity or difficulty of maintenance, adjustment, repair, and overhauling jobs on various types of farm equipment and structures. They suggest tables of characteristics, reuse values, and salvage methods and time requirements for high-value parts and materials in abandoned farm equipment and automobiles, such as gears, steel shafts, bushings, and special alloys. They suggest lists of equipment and structures not commercially available at low cost by reason of quantity production, which are useful on farms under certain conditions, and which may be built or assembled in the farm shop, as well as jobs of reinforcement and adaptation of commercial equipment.

Such lists might be accompanied by instructions for doing the work, classified according to type of shop work involved, and graded according to the extent of skill and shop equipment required. They suggest adaptable programs of progressive shop work and shop development for farm and home improvement, within various limitations as to cost, time requirements, and increasing abilities of the shop user.

AGRICULTURAL ENGINEERING

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Paperboard from Straw

ONE immediate opportunity for agricultural engineers to encourage the industrial use of a farm crop residue is in the harvesting of wheat straw for paperboard, as brought out by Dr. E. C. Lathrop in his fall meeting paper published elsewhere in this issue. Several points in his paper and the subsequent discussion deserve additional emphasis. They are interesting, not generally known, and point directly to agricultural engineering as the present limiting factor in straw utilization.

There is a present market for wheat straw—500,000 tons of it per year. In fact, straw was used before wood pulp as the fiber source for the best papers. High-grade bleached straw is even imported by the specialty paper industry. Paper makers know how to use straw, and prefer it in some respects to wood pulp. But the wood pulp interests have done a better job of solving their harvesting and transportation problem than have the straw producers. The present market for straw for paper making is in danger of being lost if the harvesting and transportation problems are not solved. If they are solved, there is a potential market for a great deal more straw than is used at present.

Dirt, lack of uniformity, and high cost are the things about straw which paper makers don't like. The fibers they want are in the stalks. All dirt, dust, leaves, chaff, weeds, and other extraneous matter involves waste transportation and processing cost to them. Elimination of these elements which they can't use is work they are now doing which they would rather pay for having done on the farm. Incidentally, these parts of the straw crop are said to be the most valuable and sufficient for returning to the soil for humus. At present the humus value of these, and the stalks too, are often being destroyed by burning.

The paper industry wants clean stalks in bales weighing about 100 pounds and bound with wire ties. Twine ties cause trouble in paper-making operations. And the paper industry can pay from $4 to $7.50 per ton for this raw material delivered at the factory. At present most of this has to pay for baling and transportation. The farmer may get anywhere from $1.50 per ton down to nothing.

What can agricultural engineers do to help farmers cash in on this market? In its present state of development for harvesting grain, the combine cuts high and scatters the straw back on the field. In the interest of low-cost operation, the combine principle needs to be preserved. This suggests modification or attachments to permit lower cutting, handling a larger volume of straw, and separation and baling of the stalks as well as separation of the grain. If the stalks can be shredded in the process, so much the better. For long-distance transportation, supplementary compression into high-density bales of small volume might more than pay its cost by reducing transportation charges.

These do not represent complicated engineering design problems. Straw separating, shredding, compression, and baling machinery already exists. From a manufacturing standpoint, however, its adaptation involves either the high cost of custom-built equipment or the speculative risk of setting up for quantity production of equipment for which the market is undeveloped and uncertain. If the necessary equipment can be simple enough, however, to be custom built at the start at costs which are not prohibitive, a market might later develop which would justify quantity production.

As a further step toward increased utilization of straw and other farm wastes and surpluses on a basis which might be mutually profitable to the farmer and to the processing industries, Dr. Lathrop requested and obtained an advisory committee of the American Society of Agricultural Engineers to work with his organization on the agricultural engineering phases of these problems. It will presumably start first on wheat straw for paperboard. A favorable factor, in addition to those mentioned above, is Dr. Lathrop's confidence that he can get paperboard mills to test and appraise the value to them of any condition of straw and type of bale which might result from agricultural engineering development of low-cost harvesting and baling methods and equipment.

In all this we see progress, from vague general concepts of agricultural engineering responsibility in connection with the industrial use of farm products to the recognition of concrete engineering problems and opportunities among which engineering performance is at its best.

Agricultural Engineers and Industrial Use of Farm Products

SEVERAL specific suggestions of work for agricultural engineers resulted from the symposium on industrial use of farm products arranged by the Power and Machinery Division for the fall meeting of the American Society of Agricultural Engineers, at Chicago in December.

It was an inspiring session, giving glimpses of tremendous new possibilities and opportunities in agriculture and agricultural engineering. The audience showed a notable warmth of enthusiasm. Still we do not anticipate any pronounced rush of agricultural engineers into the development of equipment and methods to put more American farm products at the receiving doors of the processing industries.

The reasons are clear. Agricultural engineers are and will be, for the most part, still occupied with the work they have been doing. Industrial use of farm products will depend on parallel development in agricultural engineering, farm practice, chemistry, industrial utilization, and markets for the finished products. It involves competition with mineral raw materials, with organic raw materials produced by other industries, such as fishing and lumbering, with agricultural products of foreign countries produced at low labor cost, and between farm products which are competing sources of fibers, oils, starches, proteins, and other general classes of organic materials. It involves not only field machinery, but farm structures, electrical applications, and soil and water conservation considerations. It will require a great deal of careful thought, detailed work, and patience, and is not a promising field to jump into for spectacular achievement and quick results.

What we do expect is that there will be a gradual, consistent, and substantial growth of agricultural engineering interest and work on equipment and methods to help farmers compete successfully in the industrial raw materials markets, as present agricultural engineers finish current projects; as the personnel of this field grows; as specific employment

opportunities increase for agricultural engineers in connection with industrial use of farm products; as specific agricultural engineering problems in production for industrial markets are revealed; as farmers and the processing industries come to agricultural engineers with more requests for help on specific problems; as progress creates opportunity for quantity production of new farm equipment; and as more products from farm source materials become available for engineering application as farm structural materials, fuels, lubricants, sprays, or for other purposes.

Effects of Farm Mechanization

IN A recent review of current literature we find abstracted an article, entitled "The Social Effects of Recent Trends in the Mechanization of Agriculture." The abstract reads, in part, "Temporarily, mechanization increases the individual farmer's income; but ultimately, if mechanization actually lowers cash costs, he is forced to cut his prices and at the same time pay higher costs for land and fixed costs for land, machinery, and motor fuel. The farmer also loses some of the advantages of mechanization through continually rising standards and costs of living."

The nature of competition is such that, in any widespread and highly competitive industry such as agriculture, those who would lead and thereby increase their incomes, must keep on improving their equipment and practices. It is true that any specific degree of mechanization influences other cost factors in a way which tends ultimately to neutralize the advantage of that mechanization. Furthermore, average farmers, and even the submarginal group, are continually improving their equipment and practices, so that the best and most profitable equipment and practices of leading farmers today may be only average some five or ten years hence, and still later may be submarginal or relatively backward. If a farmer advances his practices to a certain state of mechanization and efficiency, and stops his progress at that point, there is no doubt that adjustments in fixed costs and the progress of competing farmers will catch up with him.

Is it any point against farm mechanization that it has no fixed, ultimate ideal; that it must continually progress to maintain its advantage over competitors? Doesn't this mean that mechanization is an influence for general agricultural progress?

Is it any point against farm mechanization that it may result in a changed balance of costs and prices that may enable urban laborers to be better fed, clothed, and housed? Can farmers lose by performing increased economic service? Is class struggle for advantage to be emphasized over and above total material progress?

Are we to believe that sociologists in general would decry the fact that "the farmer also loses some of the advantages of mechanization through continually rising standards and costs of living"? He may lose some of the net cash advantage, but aren't higher standards of living a more real and more worthy objective? How well will he live, how much money will he make and save, and how much of an asset to his community will he be if he fails to progress in the mechanization of his operations because some of the cash advantages may be "lost" in better living?

Mechanization is no complete or perfect means to material prosperity. It is misunderstood, misused, abused, and condemned for what it will not do. But it is an aid to progress, prosperity, and better living which farmers accept and demand, scholarly treatises to the contrary notwithstanding.

Bolstering Research

FOR the past year or two the Committee on Research of the American Society of Agricultural Engineers has been particularly active. It is concerned, not with specific researches or possible projects, but with the philosophy of research in agricultural engineering, with exchange of viewpoints thereon, development of research personnel, increased mutual understanding of the several phases of research and related work, coordination and effectiveness of research, and with thorough and accurate analysis of agricultural engineering problems as a guide to professional progress.

Technical committees of the Society are concerned with specific technical problems, many of which involve questions of specific research or subject matter fields for research. It has occurred to the Committee on Research that it might now be able to be of service to these technical committees and to individuals in agricultural engineering work who may be confronted with problems of orientation in research; in other words, problems of finding a logical starting point and direction of work on specific problems.

The Committee recognizes and distinguishes between analysis of problems, statistical studies, experimentation, testing, and other methods of research. It has no quarrel with any of these methods, identified as such, nor with their proper use to contribute to maximum results for agriculture at minimum cost. It encourages increased mutual understanding of the possibilities and limitations of each. It does deplore any loose and misleading use of the word "research" as applied to routine testing and to random experimentation aimed at empirical solutions of superficial problems, or to other approaches not based on thorough analysis of the problems involved.

Likewise, the Committee recognizes and distinguishes between discovery, interpretation, and application of scientific knowledge as phases of research. It holds no brief against invention, design, development, or other attempts at practical solution of problems, but believes that these might often be more effective if more preliminary time and effort were devoted to providing more complete and accurate scientific knowledge and interpretations as a foundation for the development of practical applications.

Other matters which the Committee on Research has studied include coordination to avoid unnecessary duplication of research with resulting waste of time and funds; cooperation with other branches of science and engineering for effective work on problems which lie partly outside the technology of agricultural engineering; and dissemination and utilization of results.

Briefly, the Committee is interested in increasing the effectiveness and value of agricultural engineering research, and thereby of all agricultural engineering work. It stands ready, on invitation, to give any technical committee of the Society counsel based on a fresh viewpoint on specific technical problems, a well-developed research philosophy, and a wealth of individual and collective experience as to personnel, facilities, current problems, research in progress, and opportunities for cooperation.

Consideration of the counsel the Committee offers could scarcely detract from the achievements of any technical committee and might easily lead it to greater accomplishment than would otherwise result. For help in orienting your research problems, put them up to the Committee on Research.

The Place of Engineering in a Program of Farm Waste Utilization

By E. C. Lathrop

BASICALLY, agriculture is the science of converting chemical compounds and elements in the soil and atmosphere, through solar energy, into food, textile fibers, drugs, and other natural organic products.

Of the vast annual harvest, only the grains, seeds, fruits, leaves, or saps generally find use. Two-thirds of the total crop, the stalks, straws, seed hulls, cobs, and partially processed fibrous residues, are not now economically utilized and these are classed as wastes. The United States annually produces about 200 million tons of such wastes, of which, giving regard to plowing organic matter back into the soil to maintain fertility, more than one-half is available as a source of additional profit to the American farmer. Half of our crops represent wasted energy, lost by burning in open fields, rotting on the ground, or blowing away.

These wastes are generally fibrous. They are composed mainly of cellulose, lignin, and hemicelluloses. Few organic compounds receive as much intensive study today in the research laboratories of the world as do these three. New uses for them are being found in many fields and they will continue to play leading roles in industry in the organic chemical revolution taking place.

Utilization of these agricultural wastes is by no means a new subject. It has, like the poor, been with us for many years and many able minds have engaged themselves in the subject. Before wood pulp came into use, straw was the basis of much of the best paper. In this country today about 500,000 tons of straw is used in the paperboard industry. A small amount of high-grade bleached straw pulp is used in the specialty paper industry, but, mind you, imported. Based on the utilization of sugar-cane bagasse, the large and highly important structural insulation industry in the building field was initiated. Furfural, an organic chemical used in refining rosin, in plastics and in oil refining is profitably manufactured in large quantity from oat hulls. Other various uses for these wastes exist, but it is a safe estimate that not more than one per cent of the total available tonnage finds industrial markets.

Failure to use the major portion of this immense tonnage in the manner most profitable and efficient for the farmer is serious. The necessity of returning organic matter, humus, and mineral matter to the soil is obvious, but it should be done in a controlled fashion, since when these materials are left indiscriminately in the fields, insect pests, fungi, and plant diseases become difficult to eradicate, because this continuously available source of nutrient provides a natural medium of growth.

Establishment of industries using an appreciable percentage of these agricultural waste materials produced annually, would provide employment for thousands of people, some of whom might live on the farm.

Presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers, in Chicago, Ill., December 6, 1939. The author is Chief of the Division of Agricultural Wastes in the Northern Regional Research Laboratory (Peoria, Ill.) of the Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

ECONOMICAL HARVESTING OF CORN STALKS AND STRAW FOR INDUSTRIAL USE WILL REQUIRE THAT THEY BE HARVESTED ALONG WITH THE GRAIN CROP IN A ONCE-OVER OPERATION WHICH GIVES CLEAN FIBER AT A MINIMUM OF LABOR, POWER, AND EQUIPMENT COST

SPREAD BETWEEN FIELD VALUE AND FACTORY COST

One of the chief arguments of those not intimately acquainted with the problem is that these materials are inherently of low cost, but bitter experience has shown that the initial costs of the wastes "in the field" may be only a small part of the "f.o.b. factory cost"—the real raw material cost to industry.

For the most part, the wastes now used in industry are concentrated at central points normal to the handling of the basic crop and the costs of collection from the field are borne by the main crop and not by the waste. The use of oat hulls or cottonseed hulls is an excellent example. Since these hulls are dry, no problem of deterioration in storage is encountered.

On the other hand, sugar-cane bagasse used in the manufacture of Celotex, while available in quantities of 200 to 400 tons a day at Louisiana sugar mills, contains about 50 per cent moisture and one per cent sugar, and is contaminated with a wide variety of microorganisms. This situation led to about 30 per cent dry solids loss in one year of storage. Even more serious was the concurrent change from day to day in the physical and chemical character of the fiber, making difficult the manufacture of a uniform product.

The Celotex Company's published researches[1] covering about seven years of large-scale experiments probably represent the latest and most extensive studies on crop fiber preservation. Fiber losses were reduced to about 9 per cent by proper methods. Even though the fiber was available in large quantities many problems of baling, piling, unpiling, transportation and handling into the mill had to be solved

[1] Lathrop, E. C., Ind. Eng. Chem. 22, 449 (1930); Trans. Amer. Inst. Engineers 25, 143 (1930); and Lathrop, E. C. and Munroe, T. B., Ind. Eng. Chem. 26, 594 (1934).

by the engineering staff before really economic results were obtained.

It is obvious that the economic situation of fibers not collected at central processing plants is even less promising. At the present time about 500,000 tons of wheat straw, about 9,000 tons of cornstalks, and some small tonnage of seed-flax straw represent most of the industrial collection and use.

The use of straw in the paperboard industry is of long standing. In 1929 one of the major book and magazine paper manufacturing companies built a large and costly plant to produce fine grades of paper from straw in Ohio. This process was only operated for a few months when curtailment of production necessitated closing down. When full operation was resumed, hard woods grown locally were substituted for straw as a raw material, not because this was thought to be an inherently better source of quality fiber but due to two main objections to straw—dirt and cost.

In any but the lowest-grade product to be manufactured from fibers, exclusion or elimination of dirt, dust, cobs, leaves, and husks is imperative. At present the main portion of this burden falls on the manufacturer, whereas avoidance or elimination of such dirt and undesirables could be more effectively carried out during collection. During the past few months conversations with manufacturers indicate that they would gladly pay more for better and cleaner fibers. Under proper methods of collection there is generally the feeling that certain of these fibrous wastes might find a unique place in the pulp industries for high-grade specialties. Low dirt content is one of the main specification requirements in agricultural wastes as raw materials in process industries.

COMPETITION IN THE INDUSTRIAL RAW MATERIALS MARKET

These wastes must seek their level in the process industries. You may be assured that, due to past failures and present deficiencies in the character and handling of these products, we have to deal with a hard buyers' market.

It is generally recognized that manufacturing costs in all industries must be lowered. In the highly mechanized process industries every year seemingly impossible savings are being made. Economic conditions have forced these advances. Raw materials are likewise involved. Progress made in material collection, handling, conveying, and eliminating wastage in process industries is fully as outstanding as progress in process development. The same field of engineering in which many of the members of your Society are engaged is responsible for this development. It can be safely assumed that the process engineers will expect collection methods of agricultural wastes to measure up to standards which they have set and developed with other raw materials.

About 12 years ago I investigated the possibility of using cornstalks as a raw material for an insulation board plant to be located in the Middle West. The methods of collection and the collecting machinery at that time were such that the project was dropped. I was then and still am convinced that this problem of practically, sanely, and economically collecting farm wastes will be worked out only by the agricultural engineers of the farm equipment companies, state agricultural experiment stations, and the U. S. Department of Agriculture. The problem involves too many interrelated features of farm practice, agronomy, soil conservation, and rural economics, as well as mechanics, to expect solution by the process industries, who, after all, are pretty well satisfied with their present raw material sources.

With the great advance in motorization and mechanization of farm equipment, the problem appears capable of early solution. If, instead of having to seek a solution of the farm waste collection problem, it were necessary to start from scratch to solve the problem of securing pulp wood, let us say in the Pacific Northwest, most would agree that the latter problem would be more difficult—but this problem has received satisfactory solution.

You are asking yourselves, "Where are the markets for these farm wastes? Everybody has been talking about them but they have not materialized." The half-million-ton market of straw is declining—it will probably continue to do so unless cleaner, better-grade straw is provided. The combine does not gather this straw now, but it is conceivable that it might do so.

REQUIREMENTS OF STRAW HANDLING FOR INDUSTRIAL USE

The program of the Northern Regional Research Laboratory represents a determined effort to develop wide industrial uses for these wastes. There is no question that sound uses from the quality standpoint can be found but industry will not be convinced, nor will it be attracted to make investment until a clean-cut economical system of collection, storage, and transportation is demonstrated. The requirements of such a system are as follows:

1 Fibrous material, preferably shredded and as free as possible from dirt, worthless dust, leaves, cobs, and hulls, compactly baled, and gathered when as dry as the season permits.

2 A system of collection which avoids any duplication of effort, such as going over the field twice, baling from straw stacks, and especially raking from the ground. Rehandling entails material wastage and expense that adds nothing to the product value.

3 A system which collects these wastes at the same time as the grain or fruit is harvested so that the farmer may secure the material with a minimum of effort, making the maximum use of motor fuel, and spreading the cost of equipment amortization over as many harvested products as possible.

4 A system which maintains soil organic matter by cutting the crop so as to leave a controlled amount of stubble for plowing under.

5 A system which calls for as much processing on the farm as possible so as to bring the farmer the largest return.

For example, straw normally brings from $4 to $7.50 a ton f.o.b. factory, of which the farmer gets from nothing to $1.50 a ton. The railroads or trucking companies and the baler get the rest. This straw is sometimes shredded by the strawboard mill, dusted and even then contains dirt, using up chemicals uselessly. By a scheme of attaching a shredder, blower, small cyclone, and a baler to a combine, a cleaner, shredded, better-grade straw would result, the farmer securing the profit on shredding, cleaning, and baling, as well as pleasing and keeping a customer.

Methods are in use today which can make bales of fibrous materials as heavy as 75 lb per cubic foot. Such secondary compacting, which might be carried on at central transportation stations, would assist preservation and lower transportation and handling costs.

The successful solution of this problem involves much more than the development of the right kind of harvesting machinery, but such a machine appears to be the first major requirement.

Only by a determined, long-range, highly cooperative effort can this problem of agricultural waste utilization be solved. To recover annually even one-tenth, or one-half million tons, of this waste would go a long way in national economy. We are sure of the assistance of the agricultural engineer in this difficult but far from hopeless undertaking.

Electric Heat for Curing Sweet Potatoes

By E. T. Swink
MEMBER A.S.A.E.

SWEET POTATOES are one of the leading food products of southern farms. Prior to about 1900, few people beyond the borders of the southland could enjoy this fine vegetable, because no satisfactory method had been developed for processing it so that it could be marketed out of season, or at points far distant from the farm on which it grew. Much has been accomplished in recent years and many of the problems involved in handling this product have been at least partially solved. This is true to the extent that sweet potatoes are now found in vegetable markets almost the year round.

The high water and starch content of the matured sweet potato makes it susceptible to chilling, which results in rotting. Even potatoes that are produced free of disease require careful handling and processing if they are to be kept very long after digging. Until comparatively recent years, the only method used for "keeping" sweet potatoes was that of burying them in hills built of straw and dirt. Someone discovered that the potatoes could be kept longer if a hole or ventilator were built into the top of the hill. It is now known that after a matured sweet potato is removed from the ground a slow chemical action takes place, wherein the starch is converted into sugar. During this chemical process within the potato some heat is generated and gases are given off. The vent in the top of the dirt hill allowed a limited amount of air circulation among the potatoes. This enabled the gases to escape and prevented moisture from condensing on the potatoes, conditions that would soon cause them to rot while in storage in the dirt hill.

The next development after the ventilated dirt hill was that of a ventilated building commonly called a curing and storage house. It was found that by heating the storage house to around 85 F (degrees Fahrenheit) the chemical change within the potato could be quickened to the extent that, after a period of ten to fifteen days, the chemical process was sufficiently complete to consider the potatoes cured. It was further learned that the potatoes could be held in good condition longer with a storage temperature of 50 to 55 F. It has also been found that an air temperature of 85 F and a relative humidity of 80 to 85 per cent provide good conditions for the healing of wounds caused by broken off roots and slight cuts resulting from the digging. Under these atmospheric conditions the wounds are completely covered by what is usually referred to as the wound cork layer, by the end of the curing period. This covering prevents disease organisms from entering the potato and causing rot and deterioration.

Presented before the Rural Electric Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 7, 1939. The author is extension agricultural engineer, Virginia Polytechnic Institute.

4500-BU CINDER BLOCK CURING HOUSE IN LANCASTER COUNTY, VA. CONNECTED LOAD IS 17.5 KW. THIS HOUSE CONTAINS THREE ROOMS, THE HEATING EQUIPMENT IN EACH ROOM BEING SEPARATELY CONTROLLED

DISADVANTAGES OF HEATING BY BURNING FUEL

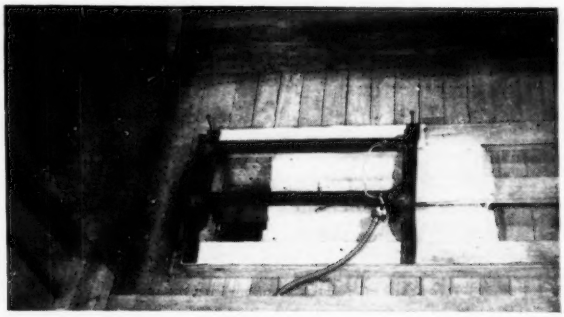
The common method of providing the heat for sweet-potato curing and storage houses has been by stoves fired with wood and coal. This method and equipment is far superior to the old dirt hill system. However, at its best it is far from satisfactory. Even with a well-designed and insulated building and the most careful manipulation of the ventilators, it is almost impossible to prevent a temperature difference of ten to fifteen degrees between the top and bottom of the house. This results in the potatoes in the top tiers being overcured or dried out and those in the bottom being undercured, both conditions causing high losses and poor quality. During the storage period, it is difficult to maintain the desired temperature of 50 to 55 F with this equipment, even with the closest practical attention of the operator. Two other disadvantages in the use of a central heating unit, such as a wood or coal stove, are the fire hazard and the space required within the building.

In 1931 a farmer near Suffolk, Virginia, in cooperation with the Virginia Electric and Power Company, conceived the idea of heating a small sweet-potato curing house with electricity. In this experiment, discarded electric street-car heaters were used for the heating units. The heaters were located under the slatted false floor and were controlled by a thermostat. The house was of frame construction and had a capacity of about 500 bu when the stove was used for heating. Use of the electric heaters increased the capacity of the house to about 700 bu. A uniform room temperature of about 82 F was maintained for ten days, at the end of which period the sweet potatoes were cured. The connected load of the heaters was about 5.2 kw and a total of 1212 kwh was consumed during the curing period. The thermostat was set back to maintain a minimum temperature of 50 F during the storage period. This farmer said that the potatoes were the finest he had ever cured, and he had little trouble getting a premium price for them. Some potatoes that were located immediately above the heaters were overcured and lost; however, the farmer was still well pleased. He had cured more bushels than he otherwise could have and received a better price for them. In addition, the electric system eliminated much labor and worry, and the actual fuel cost was little more than the previous cost of operating a coal stove.

Much study and thought has been given the subject of sweet-potato curing during the last eight years, both in Virginia and other states. The result is slightly different design of sweet-potato curing houses, using electric heating units that are now available and adapted to this special pur-

pose. The heating units most generally used are electric strip or space heaters of 500 to 1000 watts. When the total electric load is not over 25 amps, a soil heating or similar type adjustable thermostat having a temperature range of 45 to 90 F is used for the automatic control. When the power requirements exceed 25 amperes, the same type control is used with a relay or contactor.

In adapting electric strip heaters for use in heating sweet-potato curing houses, it has been necessary to increase the air space between the floor of the building and the lower tier of potatoes. This is usually done by placing the slatted floor on 2x8-in risers. The false floor is made of 2x4-in pieces on which are nailed 1x4-in slats. This provides a vertical air space of about 12 in, allowing plenty of room for the heater installations and free air circulation around the heaters. The installed heater is usually about 5 in above the floor and between the 2x8-in risers. A metal baffle sheet is placed over the heater, extending at least 12 in past each end and side. This baffle is usually nailed to the 2x4-in members of the false floor and is removable with the false floor. This arrangement allows 5 in from floor to heater, 3 in from heater to baffle, and 4 in between the baffle sheet and the nearest potatoes. These spacings and the baffle sheet allow sufficient air circulation to prevent hot spots over the heating units and eliminate the danger of overcuring the potatoes. Heating units of 1000 watts each are placed over each of the floor ventilators, warming the cool air as it enters the building. The remainder of the heating load consists of 500-watt heating units distributed around over the floor between the risers. A piece of asbestos paper is usually placed on the floor under each heating unit to prevent the floor from becoming too hot and to reduce the heat loss through the floor. The heating units are usually mounted on strap-iron supports and are covered with ½-in mesh hardware cloth to prevent rubbish or highly combustible material from coming in contact with them.



HEATING UNIT ASSEMBLY OF TWO 500-WATT STRIP HEATERS OVER FLOOR VENTILATOR. THE HARDWARE CLOTH COVER IS REMOVED. NOTE THE METAL BAFFLE SHEET ON THE SECTION OF FALSE FLOOR LEANING AGAINST THE WALL

Various types of wiring have been used in sweet-potato houses. Probably the most satisfactory and economical practice is the use of flexible armored cable mounted around the walls and on the sides of the 2x8-in risers. A plug-in receptacle is provided at each heater location so that the heating units may be easily dis- *(Continued on page 12)*

TABLE 1. DATA ON ELECTRIC SWEET-POTATO CURING HOUSES IN SEVEN SOUTHERN STATES

Location of house	Type of structure	Insulation	Capacity, bu	Connected load, kw	Type heaters	Type control	Auxiliary heat	Connected watts per 100-bu capacity	Curing temp, deg F	Curing period, days	Kwh used, curing	Kwh per bushel, curing	Storage temp, deg F	Storage period	Kwh per bushel, storing	Storage method
Alabama, Cullman	Frame	None	3000	12	Strip	R & T	None	400	85	14	1174	.80	52	5 mo	0.42	Bins
Alabama, Cullman	Frame	None	3200	10	Strip	R & T	None	312	85	13	851	.27	52	——	——	Bins
Georgia, Warsaw	Frame	None	1000	7	Strip	R & T	None	700	85	18	2006	2.00	55	5 mo	0.66	Crates
Georgia, Ranger	Frame	None	600	5.8	Cable	T	None	960	85	20	2027	3.54	55	——	——	Crates
Georgia, Monroe	Frame	None	1500	8	Strip	R & T	None	533	—	—	——	—	—	——	——	——
Georgia, Milledgeville	Frame	None	800	8	Strip	R & T	None	1000	85	15	——	—	—	——	——	——
Mississippi, Corinth	Frame	None	400	3	Wessex	T	Wood-stove	750	83	12	——	—	—	——	——	——
Mississippi, Corinth	Frame	None	1000	10	Strip	R & T	None	1000	83	12	——	—	—	——	——	——
North Carolina	Frame	Inch of Celotex in ceiling	500	3	Strip	T	None	600	85	14	550	1.1	55	4 mo	0.5	Crates
South Carolina	Frame	None	500	3.5	Strip	T	None	700	85	10	552	1.1	—	——	——	——
South Carolina	Frame	None	2000	10	Strip	R & T	None	500	85	10	1960	.98	—	——	——	——
Tennessee, Martin	Frame	None	2300	12	Strip	R & T	None	522	83	13	——	——	—	——	——	——
Tennessee, Knoxville	Frame	None	600	6	Strip	T	None	1000	82	15	——	——	—	——	——	Crates
Tennessee, Brighton	Frame	None	4000	12	Strip	R & T	None	300	83	14	——	——	—	——	——	Crates
Tennessee, Greenfield	Frame	10 in Saw-dust	7000	12	Strip	R & T	Coal-stove	171	85	13	*1525	*.23	—	——	——	Crates & bins
Tennessee, Clarksville	Brick	Wood & paper	600	6	Strip	T	None	1000	85	12	——	——	—	——	——	Crates
Virginia, Back Bay	C. block	None	2500	8	Strip	Manual	Coal-stove	320	84	14	*2050	*.89	50	4 mo	0.4	Bins
Virginia, Ottoman	C. block	Min wool	4500	17.4	Strip	T	None	386	80	12	3736	1.6	48	4 mo	0.95	Crates
Virginia, Goochland	Frame	None	2000	8.	Strip	R & T	Coal-stove	400	85	14	*1152	*.56	55	7 mo	3.7	Crates
Virginia, Drewryville	C. block	Min wool	2500	8.	Strip	R & T	None	320	82	15	2430	1.6	55	——	——	Crates

*Stove used during curing period R—Relay T—Thermostat

Land Grading Calculations

By C. V. Givan

ENGINEERS are called upon at times to supervise the grading of farm land so that it can be irrigated evenly and easily. Often it is convenient to grade the land so that the surface coincides with a series of planes. Elevations are calculated at various points so that grade stakes can be set for the grader which will provide for a balance between cut and fill. Also, it is usually desirable to hold the total volume of excavation near a minimum.

Ordinarily the engineer or surveyor can calculate the positions and slopes of the required planes with sufficient ease by trial-and-error methods. Since the trial-and-error method becomes tedious when the number of stations considered is large, the purpose of this paper is to call attention to the use of least squares as a method of calculating the plane of balanced cut and fill with a total cut which is near the minimum. When the stations on the ground are spaced at the intersection of lines which form rectangles, it has been found that the time of computation is reduced to such an extent that the least-square method has some advantage over the trial-and-error method. With such an arrangement of stations, it is not necessary to solve a simultaneous linear equation when the plane is bounded by a rectangle, and some functions of the variables which depend upon the number of stations can be tabulated.

Texts on statistical method explain the operations required to determine by least squares a plane which represents linear relationship between three variables. In the example which follows, the equation of the plane is

$$H = a + bX + cY \qquad [1]$$

wherein H is the elevation of a point on the plane, X and Y are the horizontal coordinates of the point, a is the elevation of a point on the plane at the origin, and b and c are the slopes of the plane in the x and y directions, respectively.

The two simultaneous equations for estimating b and c follow:

$$\Sigma (X_1^2)b + \Sigma(X_1Y_1)c = \Sigma(H_1X_1) \qquad [2]$$

$$\Sigma(X_1Y_1)b + \Sigma(Y_1^2)c = \Sigma(H_1Y_1) \qquad [3]$$

in which $\Sigma(X_1Y_1)$, $\Sigma(H_1X_1)$ and $\Sigma(H_1Y_1)$ are the sums of the products of the variables adjusted to deviations from the mean. $\Sigma(X_1)^2$ and $(Y_1)^2$ are the sums of the squares of the variables adjusted in the same way. These adjustments are made as follows:

$$\Sigma X_1^2 = \Sigma X^2 - n X_m^2 \qquad [4]$$

$$\Sigma Y_1^2 = \Sigma Y^2 - n Y_m^2 \qquad [5]$$

$$\Sigma X_1Y_1 = \Sigma (XY) - n X_mY_m \qquad [6]$$

$$\Sigma H_1X_1 = \Sigma HX - n H_mX_m \qquad [7]$$

$$\Sigma H_1Y_1 = \Sigma HY - n H_mY_m \qquad [8]$$

in which n is the total number of stations where elevations have been recorded, and X_m, Y_m, and H_m are the means of X, Y, and H.

The constant a is found by substitution in the following equation

$$a = H_m - b X_m - c Y_m \qquad [9]$$

The author is assistant irrigation engineer, University of California.

When elevations are taken at a number of evenly spaced stations parallel to the boundaries of a rectangle, the $\Sigma (X_1Y_1)$ becomes zero,

$$b = \Sigma (H_1X_1)/\Sigma X_1^2 \qquad [10]$$

and

$$c = \Sigma (H_1Y_1)/\Sigma Y_1^2 \qquad [11]$$

Values of ΣX_1^2 *and* ΣY_1^2 can be obtained from Table 1.

TABLE 1. VALUES OF $\Sigma X_1^2 = \Sigma X^2 - N(X)^2$ OR $\Sigma Y_1^2 = \Sigma Y^2 - N(Y)^2$

	Number of stations in either X or Y direction								
X or Y	2	3	4	5	6	7	8	9	10
1	0.5	2	5	10	17.5	28	42	60	82.5
2	1.0	4	10	20	35.0	56	84	120	165.0
3	1.5	6	15	30	52.5	84	126	180	247.5
4	2.0	8	20	40	70.0	112	168	240	330.0
5	2.5	10	25	50	87.5	140	210	300	412.5
6	3.0	12	30	60	105.0	168	252	360	495.0
7	3.5	14	35	70	122.5	196	294	420	577.5
8	4.0	16	40	80	140.0	224	336	480	660.0
9	4.5	18	45	90	157.5	252	378	540	742.5
10	5.0	20	50	100	175	280	420	600	825.0

Computations required to determine the plane when elevations have been taken at the intersections of five evenly spaced rows in the X direction and ten in the Y direction are shown below. For estimation of the yardage of earth moved, the distance between rows is established and the elevation of each station represents the average elevation of a square with sides of this length. The boundaries of the rectangular field are half this established distance from the outside stations.

TABLE 2.

Stations in Y direction	Elevations in feet, Stations in X direction						
	1	2	3	4	5	ΣH	ΣHY
1	9.8	9.2	8.6	7.8	6.8	42.2	42.2
2	9.6	8.8	7.8	6.9	6.8	39.9	79.8
3	8.8	7.8	6.9	7.2	7.7	38.4	115.2
4	8.5	7.5	7.4	8.3	8.6	40.3	161.2
5	8.2	7.6	8.4	9.2	9.6	43.0	215.0
6	8.4	8.4	9.4	9.8	11.0	47.0	282.0
7	9.1	9.3	10.2	11.0	12.2	51.8	362.6
8	9.7	10.2	11.0	12.2	12.2	55.3	442.4
9	10.7	11.0	12.1	12.3	11.8	57.9	521.1
10	11.3	11.4	11.5	11.5	11.6	57.3	573.0
ΣH	94.1	91.2	93.3	96.2	98.3	473.1	2794.5
ΣHX	94.1	182.4	279.9	384.8	491.5	1432.7	

$X_m = 3$ ft, the mean distance from the origin in the X direction between stations 1 and 5.

$Y_m = 5.5$ ft, the mean distance from the origin in the Y direction between stations 1 and 10.

$H_m = 9.462$ ft, the mean elevation of all points above datum.

$\Sigma HX = 1432.7$ ft², the sum of the products of elevations and X coordinates.

$\Sigma HY = 2794.5$ ft², the sum of the products of elevations and Y coordinates.

$\Sigma H_1X_1 = \Sigma HX - nH_mX_m = 1432.7 - 1419.3 = +13.4$ ft², the sum of the H and X products adjusted to deviations from the mean.

$\Sigma H_1 Y_1 = \Sigma HY - n H_m Y_m = 2794.5 - 2602 = 192.5$ ft², the sum of the H and Y products adjusted to deviations from the mean.

$\Sigma X_1^2 = +100$ ft², the sums of the squares of the X coordinates adjusted to deviations from the mean (From Table 1, column 5, line 10).

$\Sigma Y_1^2 = +412.5$ ft², the sums of the squares of the Y coordinates adjusted to deviations from the mean (From Table 1, column 10, line 5).

$b = \Sigma H_1 X_1 / \Sigma X_1^2 = 13.4/100 = 0.134$ ft/100 ft, the slope of the plane in the X direction.

$c = \Sigma H_1 Y_1 / \Sigma X_1^2 = 192.5/412.5 = 0.466$ ft/100 ft, the slope of the plane in the Y direction.

$a = H_m - bX_m - cY_m = 9.462 - 0.134 \times 3 - 0.466 \times 5.5 = 6.494$ ft, the elevation of the plane at the origin of coordinates.

The equation of the plane to which the land can be graded with a balance between cut and fill and with a volume of cut which is near a minimum is

$$H = a + bX + cY$$
$$= 6.494 + 0.134X + 0.466Y$$

Substitution of values of the X and Y coordinates of points at which it is desired to set grade stakes gives the elevations to be marked on these stakes. Table 3, which follows, shows numerical values of cuts and fills at each of the 50 stations. A plus sign indicates fill, and a minus sign indicates cut. The sum of the cuts is −19.49 ft and the fills is +19.44 ft, which indicates the balance obtained and serves to check numerical computations.

TABLE 3. CUTS AND FILLS, FEET

Stations in Y direction	Stations in X direction 1	2	3	4	5
1	−2.71	−1.97	−1.24	−0.30	+0.83
2	−2.04	−1.12	+0.03	+1.06	+1.30
3	−0.77	+0.36	+1.39	+1.23	+0.86
4	−0.01	+1.13	+1.36	+0.60	+0.43
5	+0.76	+1.49	+0.83	+0.16	−0.10
6	+1.03	+1.16	+0.29	+0.03	−1.04
7	+0.79	+0.73	−0.04	−0.70	−1.77
8	+0.66	+0.29	−0.37	−1.44	−1.30
9	+0.13	−0.04	−1.01	−1.07	−0.44
10	−0.01	+0.03	+0.06	+0.19	+0.23

The cuts on this field are heavier than would ordinarily be made for irrigation purposes, which indicates the desirability of subdividing the field into two or more parts, each of which can be graded to a particular plane. A field upon which relatively heavy grading would be needed was selected as an example to emphasize how closely the sum of cut and fill departures balance, even on a relatively uneven field. The equations used assume that the sum of the squares of the departures of the distances of the measured points of elevation on the land from the plane is a minimum and not the sum of the departures themselves.

Electric Heat for Curing Sweet Potatoes

(Continued from page 10)

connected when the building is to be cleaned or when servicing is necessary.

Different methods have been used in determining the heating capacity to install; however, it is desirable to follow the usual method of calculating heat requirements and heat losses based on a temperature differential considered safe for the geographical area in which the house is located. If this system is followed, the electric installation will adequately protect the potatoes for a day or longer, even at zero outside temperature.

The cost of the electric installation will naturally vary with the building size and local conditions. Experience in Virginia indicates that the cost can be roughly estimated at $65 for the first 1000-bu capacity plus about $35 for each additional 1000 bu.

It is obvious, therefore, that the curing house should be well insulated. A well-insulated building reduces the necessary connected load of heating equipment, lowers operating costs, and affords added protection in case of power failure. An incident involving one of the curing houses in Virginia forcibly illustrates the importance of good insulation. Soon after the storage period had started, there was a heavy snow and ice storm that put the power lines out of commission. Service to this new 4500-bu house was off for 46 hr and the temperature of the storage house only dropped from the 50-deg minimum to 44 F. This building was constructed of 8-in cinder block, insulated with 2 in of mineral wool on the inside walls and 4 in of mineral wool on the ceiling, and was ceiled with gypsum board. Without a doubt, serious damage would have resulted had less insulation been put into that building.

Table 1 gives condensed information on twenty electric sweet-potato curing houses known to be in operation in seven southern states. These houses vary in size from the smallest individually owned house to a 7000-bu cooperatively operated one. Some of these houses are old buildings that have been converted into sweet-potato curing houses. Most of them are of frame construction, based on plans provided by the U.S.D.A. In the insulation column, the word "none" is used to denote that standard construction is used with no supplementary insulation. This construction consists of weather boarding, building paper, storm sheathing, 2x4-in studding, and tongue-and-grooved ceiling on the inside. So many variable factors are involved that it is difficult to arrive at conclusions by comparing data on these houses. Differences in geographical location, building construction, length of curing period, curing temperature, weather conditions during curing, condition of the potatoes when placed in the building, and procedures followed by the operators all make a comparison or average figures somewhat impractical. Any one of these factors could easily justify the difference in the amount of electricity used in any two houses. The fact that many of the houses were not filled to capacity also makes the electricity required per bushel both high and erroneous from a comparison standpoint. At any rate the data provides interesting facts for study. Probably the most valuable and interesting fact disclosed in this survey is that every single operator was well pleased with the results obtained from the use of electric heat. The data on the electrically operated curing houses was secured through the cooperation of extension specialists in rural electrification in the various states.

There are many differences of opinion on the most desirable temperatures to maintain in the curing and storage of sweet potatoes. The correct answers to these questions can be obtained only through a study of the physiology of the sweet potato and the relation of time, temperature, and humidity to the changes that take place during curing and storage. As to the status of electricity as a desirable form of energy for producing heat for curing and storing, the results from practical installations definitely establish it as the best and often the most economical fuel for the purpose.

Appraisal of Insured Farm Building Risks

By L. G. Keeney
ASSOCIATE A.S.A.E.

EARLY in 1934 a fire and wind risk inspection bureau was set up to serve county mutual insurance associations writing farm property insurance in Iowa. This plan was a direct result of a research project sponsored jointly by the Iowa Mutual Tornado Insurance Association and the Farmers Mutual Reinsurance Association. The research program was carried out in the agricultural engineering department of Iowa State College under the direction of Professor Henry Giese. Fire loss statistics gathered from the files of the Iowa fire marshal's office showed conclusively that a large part of the rural fire waste could be classed as strictly preventable. Similarly field studies showed that a vast amount of wind damage to farm buildings was due to faulty construction rather than to severe windstorms. A good share of the fire and lightning insurance on Iowa farm buildings is written through 154 county mutuals operating in limited territories. The tornado risk is carried largely by the Iowa Mutual Tornado Insurance Association operating on a statewide basis, since few of the county mutuals care to take the risk of devastating storms in their limited areas.

The Reinsurance Association serves the county mutuals by underwriting parts of large farm risks which the smaller companies would hesitate to carry alone, and by giving additional stability by means of blanket reinsurance against excess loss. The staff of inspectors carrying on inspection and appraisal work is employed and supervised by the Reinsurance Association, although the cost of the work is distributed among all companies interested. To date more than 50,000 sets of farm buildings have been inspected by these men. Accurate records of all farm inspections made have been kept and summarized periodically, and the results have been startling even to those familiar with rural building conditions. For instance, approximately one out of every five farm dwellings was found to have a chimney defective in the attic. The number of defects in lightning protection systems, heating systems, electrical wiring, and other equipment affecting the fire risk has been far greater than anticipated when the work was first started. Much has been accomplished in remedying these serious defects, and the trend toward reduced losses certainly justifies the work and expense involved in making the inspections.

The need for accurate appraisals of insured farm buildings became apparent soon after the inspectors began work several years ago. Most farm property insurance companies have tried to write insurance on each building at approximately three-fourths of its present cash value. In this manner the assured is carrying a share of his own risk and is, therefore, much more inclined to keep his property in good condition. Also, the possibility of an unscrupulous person "selling out" to an insurance company is remote if the property is written below its actual value.

Presented before the Farm Structures Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 6, 1939. The author is chief inspector, Farmers Mutual Reinsurance Association of Iowa.

THIS BARN IS LOCATED ON A FARM OPERATED BY A TENANT WHO FARMS ALMOST ENTIRELY WITH TRACTOR POWER. THE BARN HAS NOT BEEN USED FOR SEVERAL YEARS, YET THE OWNER AND THE MORTGAGEE BOTH INSISTED UPON HAVING IT INSURED. INSURANCE CARRIED WHEN FOUND BY INSPECTOR, $800

RESPONSIBILITY OF APPRAISERS

Farm property insurance as written under the county mutual plan is a pure form of cooperation. The loss of an over-insured building must be paid by other policyholders. The responsibility of giving fair, adequate coverage rests with the persons making appraisals. From the standpoint of the insurance company it is essential that the proper value of a building to be insured is decided upon before the insurance contract is issued. A stipulation in the policy form used by most Iowa companies limits the liability of the insurer to the actual cash value at the time of loss. However, a post-loss appraisal is difficult to make, and the company invariably pays the full amount of the insurance carried when over-insured property is destroyed.

In addition to being of service to his company, the appraiser is also able to assist the farm owner in the matter of adjusting the farm budget to provide for building needs. Many farm owners have little idea as to the actual amount of their building investment and have not taken into account the fact that their buildings have depreciated rapidly and that proper allowances should be made for upkeep. That farm owners are interested in intelligent planning of their building program is evident from the counsel they are seeking from the inspectors.

It is generally accepted that appraisals can be made most accurately on the basis of replacement cost new. After this figure has been determined, deduction for depreciation and lack of utility value can be made according to the needs of the situation at hand. The determination of the replacement cost new is dependent upon the ability of the appraiser to adapt his knowledge of building construction to prevailing building costs in the territory in which he is working. One of the problems insurance appraisers have had to meet is that of making corrections for lowered building cost during the past ten years as compared with the extremely high cost in 1920. The farmer who spent $12,000 for a dwelling in 1920 may feel that he is making a concession to the insurance company if he allows it to place the insurable value at $8,000; yet the same dwelling today could probably be built for less than the amount of insurance carried. The majority of property owners look at the original investment rather than at the present worth of the property. Based on average building material and labor prices, a typical farm building, which could have been built for $300 in 1913, cost in the

neighborhood of $1000 in 1920, and at the present time could be reconstructed for approximately $500. It is, therefore, necessary for the insurance appraiser to have a full understanding of the past history of building costs.

There is considerable variation in farm building cost, even within the boundaries of one state. We have tried for some time to base our cost estimates each year on average material and labor costs in our territory. However, in 1938 prices for carpenter labor ranged from 40 cents to $1.25 per hour in areas not more than 100 miles apart.

As many farm buildings are temporary in nature, physical depreciation is perhaps one of the most indefinite parts of appraisal. We have made no attempt to set up a depreciation table but have obtained as much information as is available from outside sources. Past issues of AGRICULTURAL ENGINEERING have carried depreciation tables which were worked out for various types of construction on the basis of the number of years of expectancy, with yearly depreciation charges applied on a straight-line basis.

The following approximate estimates are quite generally used in our territory and are figured on the assumption that a building receives little or no repair. As proper credit should be given for expense and upkeep, the percentages would be high for buildings kept in good condition. Depreciation rates for farm dwellings will range from 1½ to 2 per cent per year; for barns, 2½ to 4 per cent; and for most outbuildings of average construction, from 2¾ to 4 per cent. From the standpoint of the insurance appraiser, physical depreciation should be limited to not more than 60 per cent of the present replacement value. That is, of course, a general rule, and it is based upon the theory that a building worth less than 40 per cent of its replacement cost would not be insurable.

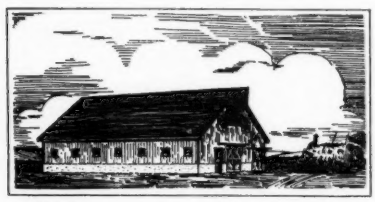
CHANGES IN AGRICULTURE INFLUENCE USE AND APPRAISED VALUES

The constant changing of agricultural activities, due largely to drought conditions and the introduction of new crops and new methods of farming, has played an important part in farm property values. The southern part of Iowa a few years ago was one of the leading cattle feeding sections in the state. However, after five or six consecutive years of extreme heat and little rainfall, the farmers were unable to keep up their herds and as a result were forced to turn to extensive farming. Many farms were over-improved during the boom years and have far more investment in buildings than the farms themselves will justify. Others have been improved with money not earned on the farm. In such cases it is necessary for the insurance appraiser to determine the maximum value of each building to the particular farm where it is located and to estimate its insurable value accordingly. Farms which were at one time quite large but which have been divided into smaller units, present another problem. In one case, a 1000-acre farm had gone under foreclosure, but the owner had managed to salvage 40 acres upon which the buildings were located. Our inspector found a very large dwelling insured for $10,000. Because of the poor location of the farm the dwelling had no value except to house the people who operated the farm. At the time the inspection was made this entire farm would not have brought $1000.

As no hard and fast rules can be made for upper limits of service and utility value, final decisions will depend upon general conditions. In general the following points should be considered in studying each case:

1 Values of buildings not necessary to the operation of the farm should be discounted.

2 Rented buildings not used in connection with the farm have little value.



POLE BARN
52' x 72'

Midwest Plan No. 72431

TOTAL COST in 1938--$ 2,733.50

DESCRIPTION	
CONSTRUCTION	Pole
FOUNDATION	8" Concrete Wall
WALLS	Posts- built of 2"x8" Lumber 2" x 6" Studding-2'-0" O.C. 2"x6" & 2"x8" Girts 12" Siding (Laid vertical) 5/8" x 2-1/4" Battens
FLOORS	Dirt
ROOF	2" x 6" Rafters-2'-0" O.C. 6" Sheathing- solid 2" x 6" Braces Wood Shingles
INTERIOR FINISH	Unfinished
IMPROVEMENTS (not included in Cost Data)	None

COST DATA

CUBIC FEET. 77,500
SQUARE FEET 3,744

YEAR	COST DATA	COST PER CU. FT.	COST PER SQ. FT.
1938	100%	0.035	0.73
1939	%	0.	
1940	%	0.	
1941	%	0.	
1942	%	0.	
1943	%	0.	
1944	%	0.	
1945	%	0.	
1946	%	0.	
1947	%	0.	
1948	%	0.	

TYPICAL SHEET FROM "FIELD MANUAL FOR INSPECTION AND APPRAISAL OF FARM INSURANCE RISKS"

3 Buildings occupied by tenants should be limited in value to the amount which would probably be spent in replacement in case of loss.

4 Dwellings only partly occupied should carry a value no greater than that of a smaller building which would serve the purpose.

5 The estimated value for all buildings should not exceed from 70 to 80 per cent of the total value of the farm. The dwelling should be limited to a maximum of 35 per cent.

6 If the farm is mortgaged the total value of the buildings should not exceed the amount which would be spent to replace them in case of loss.

Several texts on farm building appraisal are available, most of which have been too complicated for the farm insurance agent to use. It has been necessary to attempt to devise some method of arriving at insurable values which would be fairly accurate and still not require a great deal of time for computation. One of the first methods adopted by our appraisers was that of comparing buildings to be appraised with others of known value. New buildings where contract costs could be obtained were photographed, and the costs were broken down to square-foot and cubic-foot units. Although this method works fairly well, it also has its shortcomings. It is sometimes difficult to arrive at the actual cost, because frequently some old material is used and the farmer or tenant takes care of some of the rough labor and does not include it in the cost estimate. If these costs are to be used for compari- *(Continued on page 16)*

More Basic Research in Farm Machine Development Needed

By G. Douglas Jones
FELLOW A.S.A.E.

ALL RESEARCH work falls within one or a combination of three great realms, namely, (1) the realm of discovery, (2) the realm of interpretation, and (3) the realm of application, according to Dr. Glenn Frank. The realm of discovery may include a principle, a law, a method, a means, or a fact, but it also must include proofs whereby the theorem may be transposed to an established fact or truth. The realm of interpretation is the intermediate area wherein the discovery is interpreted in terms of application. The realm of application is that in which the discovery brought out in realm one and interpreted in realm two is taking form and being actually used, applied, or recognized in life relationships.

Much that has been accomplished in the farm equipment industry under the general term of "research work," undoubtedly falls in the realm of application. The need for greater activity in realms one and two is becoming more and more important. Unfortunately but little is being done in these two realms by the industry today. The import of this situation, as it affects agricultural development, may be gained from the results of activity in these realms by research men in other industries.

You are all familiar with the great research organizations in other lines of industry, such as are maintained by Du Pont, Eastman Kodak, American Telephone & Telegraph, General Electric, General Motors, Westinghouse and others. Every one of these organizations is interested first in the activity of realm one, realizing that here are the great areas of unknowns, into which one must delve before he can make progress, even into the realm of interpretation, and then in its application.

It was at the expense of time, effort, and considerable money that Du Pont discovered "nylon". Du Pont knew that if effort toward interpretation and application of this discovery could succeed, a vast and unlimited new market would be opened up. They had brought about an improvement which the public would demand. The result of this discovery, the interpretation thereof, and the development needs no further comment. We all know how successful it has proved and how essential it appears to modern life of today.

Let us look for a moment at the farm equipment field and consider the advances we have made in soil working tools, harvesting machinery, tractors, and other equipment. There have been improvements and revisions all along the line, but all of the activity has been in realm three.

Presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers, in Chicago, Ill., December 6, 1939. The author is agricultural engineer, Cleveland Tractor Company.

It might be well for us to ask ourselves what new product based upon a thoroughly new discovery, such as described in realm one, has been made by our industry? Let us take the cultivation of row crops as an illustration. There have been great improvements in cultivator steels. There have been many improvements in chassis. There have been numerous improvements in carrying means, but approximately all the time spent on these subjects falls in realm three. How much effort have we put forth to discover new facts about the thoroughly fundamental significance of other factors that must, and eventually will, be met.

The average farmer uses only one type of cultivator steels on his cultivator. Are the shapes of cultivator steels correct? Will the same shapes perform efficient work in varying types of soil? Should the farmer have three or perhaps four sets of shapes for different soil types and stages of crop growth? I question the necessity for this. I sometimes question the necessity for any kind of mechanical cultivation. I think you will agree that in place of the utter lack of definite knowledge of biological mechanics which now exists, a complete understanding based upon a definite knowledge of biophysics is required before we can attempt an answer.

Consider plow bottoms and shapes. Few if any farms in this country can boast of one soil type. Soils vary throughout a field. The farmer uses one shape of moldboard for spring plowing when maximum granulation is desired, especially in clay soils, and the same bottom for minimum granulation in fall plowing. Is this good procedure? Do we know? Again the lack of fundamental knowledge of the behavior of soil structures leaves us without the facts so necessary for a complete understanding.

Consider this problem: What would happen after planting a row crop, if we should so work the soil that a complete puddling action takes place, and a good job of puddling has been done when the sun has performed its work of crusting and cracking the soil? Suppose, then, that we use an implement to granulate this crusted surface soil to the desired granular structure which remains for a long time. The solution of this problem may lead to uncovering of some important facts. The indicated research here must be carried on in realm one.

There is no branch of industry and no branch of American life that presents such dire need for fundamental research, certainly none wherein the possibilities are as great in realm one, as our American agriculture.

Admitting the lack of any measuring means or yardstick in the needs area, there is no doubt but that the soils area is our fundamental

problem, for it is the elements carried in and composing our soil structure, plus radiant waves and moisture, through which our crops are produced. With all due respect to the magical hydroponics, I still believe that "Mother Earth," rather than tanks of aerated water containing numerous chemicals, will continue to be the main source of food supply for our crops.

The need of an accurate measuring means has been pointed out by John A. Slipher of Ohio State University. He contends that "until a yard-stick or other measuring means is developed or established, especially as to the physical characteristics of our soils, little progress in implement development can be made". Again this takes us into realm one.

The farm equipment industry is an essential industry, perhaps *the* essential industry, since its sole purpose is to produce equipment for the basic human enterprise, farming. My thought is that we should be increasingly responsive to any effort that looks to new discoveries to meet the needs and opportunities in the area of human enterprise which it is our good fortune to serve.

The industry's responsibility is not only that of ways and means, in realm three, but also in the "whys" of realm one. The industry must broaden the concept of its responsibility to agriculture through deeper and more fundamental research.

Henry P. Kendall, in an address before the fourth annual research conference at Ohio State University on November 3 last, said: "An organization steeped in the research idea, its executives and workers all thinking of problems and studying carefully their solutions with the zest the scientist brings to his work, is something more than an organization. It is an organism with opportunities for growth stretching out both for the individual and for the company." I believe that the farm equipment industry should strive to reach this status in its research philosophy. It will be reached when differentiation is made between research, experimentation, and development, and when these activities are properly classified in their respective realms.

The several public service institutions have assisted and continue to assist this industry. No class on earth has and still is receiving so much help, both through advice and financial aid, as the farming industry. We cannot and must not depend upon public institutions, especially the Department of Agriculture, to do our research work for us. Rather should we work more closely together. There is, however, no finer example of cooperation than is shown by the Department of Agriculture in providing the great possibilities which its laboratory at Auburn, Alabama, presents to our industry. While it is agreed that most of their work in the past has been confined to realm three, I feel safe in saying that the U. S. Tillage Machinery Laboratory will welcome cooperation with any manufacturer who desires to work in realms one, two, or three. I am certain that the U. S. Bureau of Agricultural Chemistry and Engineering is anxious to cooperate with the industry and would approve any reasonable request for a project setup in research on agricultural problems, especially those that can be performed at the laboratory.

By all means, let us not spend too much time in realm three, the realm of application, but rather put our efforts on realm one, the realm of discovery. Our public service institutions will, I am sure, be glad of the opportunity to counsel and assist any of us who present our problems to them.

Appraisal of Insured Farm Building Risks

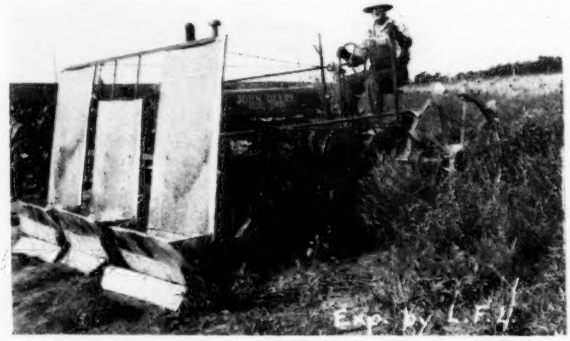
(Continued from page 14)

son with other buildings, they must be sufficiently accurate to warrant their use. Another method is that of using the original cost new and then applying a correction factor to compensate for fluctuation in cost. This method has some merit but fails in many cases because there is usually not sufficient information available to obtain any degree of accuracy.

About two years ago another solution to the problem was attempted by our companies. Several typical buildings were chosen from the Midwest Building Plan Service and material and labor costs for each building were figured, according to average prevailing prices. The replacement cost new was determined and was broken down into square-foot and cubic-foot costs. The year 1938 was used as a basis of 100 per cent, and provisions were made on each sheet for corrections to be made each year on a percentage basis. The cost of the structure alone was included in the unit costs, and necessary additions were made in lump sums to provide for whatever improvements were found in the building in process of appraisal. The chief shortcoming of this system was referred to earlier, namely, that of variation in material and labor costs in various territories during the same year.

We are making plans for another set of cost sheets which will be more easily adapted to changing conditions. This plan will embody the inclusion of 20 or 25 typical farm buildings as simple in construction and plan as possible. A general labor index will be plotted against a material index, thus making provisions for a wide range of costs. Each sheet will show a complete set of square-foot and cubic-foot costs, together with correction factors to be used in compensating for variations in size. When beginning work in a particular locality, the appraiser will obtain sufficient material and labor cost information to establish the indexes. After choosing the typical building most similar to the one to be appraised, he can then select the proper unit cost from the table quickly and easily.

It is evident that progressive insurance companies are desirous of establishing fair values for insured properties on an intelligent and logical basis. Thus the companies are not only protecting themselves, but they are improving the position of the policyholder by requiring him to pay premiums only on the amount he can rightfully expect to collect in the event of loss. The use of cost schedules which are sufficiently flexible to provide for variations in replacement costs, together with the application of sound principles relating to depreciation and service value of farm property, will enable the insurance appraiser to give greater service to all concerned.



TRACTOR-MOUNTED GRASSHOPPER CATCHER BUILT IN THE AGRICULTURAL ENGINEERING DEPARTMENT, UNIVERSITY OF NEBRASKA, AND USED WITH ONLY MODERATE SUCCESS IN A CORN FIELD

Causes of Failure in Tile Drains

By Fred F. Shafer
MEMBER A.S.A.E.

INFORMATION presented in this paper is based in a general way on about thirty years of personal experience and observation in thirty-six states, but more particularly on a large volume of repair work done on public tile drains in Ohio, during the past four years, by CCC drainage camps.

There are five broad bases under which all failures of tile drains may be classified, namely, (1) manufacturing processes and materials used, (2) improper design of the ditches, (3) improper construction, (4) lack of inspection and maintenance, and (5) physical structure of the soil.

Manufacture. Two kinds of materials are used in the manufacture of drain tile—cement and aggregates, usually sand and gravel or crushed stone, and clay or shale. The failures of concrete tile, due to improper manufacture, are generally traceable to common faults in concrete structures, namely, improper or unclean material, poor or weak mixtures, and improper mixing and curing. Any of these faults will produce a grade of tile that will not stand up under earth pressures frequently encountered, nor withstand the natural freezing and thawing processes, the result being failure by crushing and disintegration.

Failures of clay and shale drain tile due to improper manufacture constitute about one-fifth of all failures investigated and shown in Table 1. The chief faults of the early clay tile were inadequate strength and lack of resistance to freezing. Until about 25 or 30 years ago drain tile were judged largely by their color, and the tone given out when struck a sharp blow; the cherry-red colored tile giving out a clear, ringing tone were presumed to be the best.

As land values increased, larger tile were used to replace the small open ditches, and they were laid at greater depths, 12 to 15 or 18 ft being common. Within a short time failures by crushing of the tile were rather numerous. About 1911 the Iowa Agricultural Experiment Station undertook a study of the earth pressures on tile in trenches and developed a laboratory method of testing the strength of tile.

COMBINATIONS OF CAUSES OF FAILURE

Unfortunately, it was difficult to find satisfactory records of the dates when the tile shown in Table 1 were laid. However, from personal knowledge of a number of tile replacements due to failure from pressure, the tile were between 30 and 40 years old.

Apparent failures due to crushing may be from a combination of poor quality tile and improper laying. Frequently not enough care was taken to give supporting foundation, so that the pressure on the tile, from weight of earth above, was not distributed over the bottom 90-deg arc of the tile.

Improper Design. Failures of tile drains due to improper design include (a) insufficient capacity, (b) lack of adequate cover and depth, and (c) lack of adequate and/or sufficient number of auxiliary structures.

Insufficient capacity does not appear to be responsible for a large percentage of failures. Thirty or forty years ago, ¼-in drainage coefficient was considered adequate and many tile drains were so designed. The result was that much surface water from the tiled land flowed off through shallow water courses or old open ditches. Failures due to insufficient capacity will in this case depend on the extent and frequency of storm water runoff passing over the surface of the land, and the extent of damage resulting from water standing too long over the tile lines. If the soil is loamy or loose, and if surface inlets are provided over the tile, it will be possible to have the water under pressure in the line. Sometimes this pressure builds up 2 or 3 ft of head, and where there is insufficient cover, the water is forced up between the joints and "blowouts" occur. Frequently rather long reaches of tile are uncovered, and, if not repaired, the tile will be broken down from farming operations or from freezing and thawing. Tile lines subject to internal water pressure are particularly objectionable where they extend through sand and muck soils.

IMPROPER TILE LAYING IN OPEN DITCHES

A great many tile drains were laid in open ditches and partially backfilled. In many cases there was insufficient depth of earth to protect the tile from freezing or from breakage by farm implements. Where the tile lines were too small and became overloaded, the water under pressure caused "blow holes" along the tile. Lack of sufficient cover also permits uncovering of the tile by storm water flowing over it. Tile will operate satisfactorily under pressure for short periods of times in heavy clay soils, provided there is 2 or 3 ft of well-compacted earth over it.

Catch basins properly designed and installed are important since they permit surface water to enter the tile rapidly and thus provide more adequate drainage. Catch basins not properly constructed may be the source of considerable damage. The most common failure of catch basins is that they are not made tight, so that water washes dirt into them and into the tile, which may cause stoppage of the line. Open catch basins will permit trash to wash into a tile, thereby clogging it.

Poorly designed and constructed headwalls at the outlets of tile usually wash out or around the ends; they are generally sagging over towards the ditch, and quite often have fallen in. Tile just back of a headwall that is inadequate are always uncovered, and very often broken in, clogging the line, and requiring expensive repairs. In most cases where headwalls are constructed at large tile outlets, surface storm water must be taken care of. Practically none of these headwalls have sufficient weir notch capacity to handle this storm water properly. The result is the headwall is washed out and stands alone. If it doesn't fall over, it stands as a sad reminder of poor engineering design. Headwalls also fail for lack of proper foundations and design to prevent undercutting where the water discharges from the tile.

Improper Construction. The tabulation indicates that about one-fourth of the failures can be attributed to poor or faulty construction. Improper construction may be broken down into (a) poorly constructed joints, (b) failure to shape the bottom of the trench to fit the tile, (c) uneven grade, (d) careless backfilling, (e) carelessness in making tight junctions of laterals, (f) lack of careful laying in

Presented before the Soil and Water Conservation Division at the annual meeting of the American Society of Agricultural Engineers at St. Paul, Minn., June 20, 1939. The author is inspector of CCC drainage camps in Ohio, U. S. Bureau of Agricultural Engineering.

sandy soil, quicksand pockets, and in muck, and (g) poor alignment.

Poorly constructed joints permit dirt to enter the tile, and form holes over the course of the drain. The material washed into the tile may remain there to clog it. If storm water runs over the tile, it will further increase the size of the holes, and make farming operations hazardous and dangerous to stock. An examination of a hole over a tile line will invariably reveal a large crack between tiles where water has run in. Individual tiles are sometimes found in all manner of positions in quicksand pockets. This condition may be due to water under pressure being forced out at the joints and disturbing the base.

It is believed that in many cases where tile have apparently been crushed from earth pressure, this could have been prevented had the bottom of the trench been properly shaped so that the pressure could have been distributed evenly over about 90 deg of the bottom section of the tile. A rounded bottom in the trench will also permit laying the tiles closer together, thus avoiding some of the effects of open joints.

Uneven grade is responsible for a considerable number of failures especially if there are high points, or "back fall" in the line. The effect of this is to reduce the velocity of the water so that it will fail to clean the tile.

Careless backfilling may cause tile to be crowded out of line, or even break some of them. If holes or large openings are left in the trench, surface water will readily find an opening between the tiles and tend to create holes over the line.

A large number of holes over tile lines can be attributed to carelessness in making tight lateral connections; such open connections permit dirt to enter the tile.

A great many tile failures are caused by improper construction through water-bearing sand or quicksand, and in muck. It is very difficult to place and keep tile on proper grade and clean under such circumstances. It is not a job for an amateur, but rather one for an expert.

Poor alignment of tile lines results in open joints with the various detrimental results indicated previously. It also retards the velocity of the water to a certain extent and, of course, reduces the capacity of the tile.

RESULTS OF NEGLECT OF TILE AFTER LAYING

Lack of Inspection and Maintenance. The previous three general causes of failures may be considered primary in nature. This last is secondary in that, with reasonable inspection and repair, many of the failures indicated could have been corrected and prevented. The types of failures due to lack of maintenance are (a) filling with silt from openings over the line, (b) filling due to washed-out catch basins and other surface inlets, (c) stoppage of the line due to root growths, and (d) neglecting to keep the outlet open, which permits water to back up in the tile. Several things happen when this occurs. The tile is put under pressure, "blow holes" occur, and the line often becomes uncovered. Exposure to weather permits disintegration by freezing. Water standing in the line may freeze and fracture the tile, causing it to fail.

Structure of the Soil. The type of soil where some failures have been reported usually is a very heavy or dense clay, which prevents the movement of gravitational water through it. Such areas are quite limited in extent and locality. I have observed only a very few such locations, where it was alleged that tile drainage was not effective. There may have been other factors present that affected drainage.

Table 1 was prepared from a study of 165 repairs made to public tile drains during the period from 1936 to 1938, inclusive, in Defiance, Hancock, Delaware, Wood and Williams Counties, Ohio. This repair work was done by CCC drainage camps located at Defiance, Bowling Green, Findlay, and Delaware.

TABLE 1. PROBABLE CAUSES OF FAILURE OF TILE DRAINAGE IN CERTAIN AREAS OF OHIO

Number of cases	Per cent of total
Manufacturing processes and material 34	20.6
Improper design 46	27.9
Improper construction 38	23.0
Lack of inspection and maintenance 47	28.5
Physical structure of the soil 0	0
Total 165	100.0

The following are suggested remedies of drain tile failures:

Manufacturing Processes and Materials. It was shown in the discussion of failures under this heading that most of them occurred on tile lines that had been installed for 30 or 40 years, before improved manufacturing processes had been in use. At the present time there is little excuse for failures of tile due to excessive earth pressure. Those interested in ascertaining how to obtain tile of proper strength can get this information from the engineering colleges and agricultural experiment stations in their states. It is the obvious duty of the engineer in charge of the project to be informed of the A.S.T.M. specifications for drain tile and to see that tests are made according to these specifications.

Improper Design. The design of an expensive tile drainage system is obviously a function of a qualified drainage engineer. In far too many cases drainage work is turned over to the county engineer, who may have little or no training or experience in drainage matters. If the engineer is interested in properly informing himself, a great deal of technical data is available in various state and federal publications. Here again the state engineering colleges and agricultural experiment stations can be called on for advice and assistance.

Improper design of tile drains and auxiliary structures accounts for nearly 30 per cent of the failures studied. A great deal of public funds have been wasted or misspent for lack of adequate engineering.

Improper Construction. Under this general heading it was indicated that nearly one-fourth of the failures occurred. Much of this was due to lack of proper engineering inspection, and inexperienced or crooked contractors. Perhaps funds are not always provided to employ competent engineering inspection and detailed surveys so that adequate plans may be developed. The remedy here would be to provide funds for competent and adequate engineering.

Lack of Inspection and Maintenance. It seems to be the common impression of landowners and others that once tile are installed they should continue to function indefinitely without any attention. The volume of repair work done on tile lines by the CCC drainage camps certainly disproves the popular impression. It should be noted in the above table that this cause of failure heads the list with 28.5 per cent. Periodic inspections and a reasonable amount of timely repairs would save a lot of damage and many costly repairs.

Probably the remedy for this condition lies in modifying or amending the existing drainage laws so that some county official shall be made definitely responsible to take action when cases needing repairs are called to his attention; it might help if there was a penalty provided for failures to care for maintenance. *(Continued on page 20)*

Revelations of a Farm Machinery Survey

By Earle K. Rambo
JUNIOR MEMBER A.S.A.E.

FROM June 1 to September 15 of this year, I worked with the Tennessee agricultural extension service, making a brief farm machinery survey and giving repair demonstrations in seven counties.

Requests from time to time for extension assistance in farm machinery and equipment work could not be filled because of limited personnel and because of uncertainty of the probable extent and scope of such demand. The intensive county program planning by the extension service now going forward in specified counties is considered a supporting factor in favor of investigating conditions surrounding farmers' machinery and equipment necessities, since these counties offer a fair representation of the state and later similar surveys may offer supporting evidence of progress made in program execution.

Objectives, as set up in the plan of work, were (1) to yield a state cross-section view of farm machinery equipment in use and machinery equipment conditions in Tennessee in the summer of 1939; (2) to give a view of farmer attitude in equipment upkeep and toward extension demonstrational work in the subject; and (3) to demonstrate repair methods on mowers, as one commonly used type of equipment.

The seven counties visited in the order named were Claiborne, Bledsoe, Coffee, Giles, Hardin, Henry and Humphreys.

The walking moldboard plow, double shovel, bull tongue, one-row corn planter, mower, hay rake, disk harrow, and spike-tooth harrow are practically standard equipment in all of the counties I visited.

Other farming implements commonly found were hillside plows in Claiborne, Bledsoe, and in parts of Henry and Humphreys Counties; grain drills in Coffee, Giles, and in parts of Bledsoe County; two-row planters in Coffee, Giles, and in parts of Hardin County; manure spreaders in Coffee County; potato plows in Henry County; soil packers and land rollers in Henry and Humphreys Counties; some combines in all seven counties; and a few reapers in Coffee and Henry Counties, used primarily for bunching clover.

COMMON MOWER TROUBLES

Since I found more farmers having trouble with mowers than with any other one tool or machine, I will attempt to give a picture of some of these troubles. On the very first farm visited, I found the wearing plates on a mower upside down. On another farm one of the late model oil-bath mowers had been discarded after two and one-half years service because it overloaded the team and would not cut clean. The homemade pitman rod was about 1½ in too long, so the sections did not register in the guards at each end of the pitman stroke. A new pitman rod would have remedied the trouble. However, the farm manager stated that he had requested the dealer to send a man out to check it. The dealer failed to do this, so the machine was discarded and replaced by a new machine of another make.

In Bledsoe County, three mowers in one community had to be discarded because of broken frames. These frames had been broken by rollers from the roller bearings getting out of the race and piling up on one side of the axle in the frame. Usually this can be prevented by putting a washer around the axle at the end of the frame to prevent end play on the axle. This in turn will keep the roller-bearing race from becoming exposed and practically eliminate bearing crushing.

In Coffee County, I found several late model mowers equipped with lespedeza cutter bars on which the knife sections were stopping half way between the guards. One farmer last year purchased a new mower which pulled so hard that the dealer sent a company service man out to check it. New bearings were put in throughout, but the draft was still too much for the team. The weight on the neck yoke on this mower caused sores on the horses' necks. When I checked this machine, I found that the bolt in the end of the lifting spring was screwed up within an inch of the head. On this particular machine, at least 3½ in of threads should be showing on this bolt. After adjusting the lifting spring tension I checked the alignment of the cutter bar with the pitman rod. This was correct, but the cutter bar was not perpendicular to the line of travel. The outer end of the cutter bar was lagging about 6 in. After making all necessary adjustments for alignment and registration, I asked the farmer to take the machine for a tryout. The tryout was made in heavy grass. The driver stopped his team several times and started again without backing up. The machine did not choke.

SIMPLE ADJUSTMENTS IMPROVE PERFORMANCE

On another farm, the mower in use had broken three knife ribs this season. This particular make and model mower is equipped with an eccentric bushing on the rear hinge pin. It took less than ten minutes to remedy the cause of those broken knife ribs.

Only a small per cent of the farmers visited knew that the wearing plates on most mowers are adjustable, that the lips of the guards should never be bent down against the knife sections, or that guard plates which are riveted in can be changed without removing the guards.

In two counties I found dealers of the same farm machinery manufacturer with new mowers which were out of adjustment on the sales floor.

In Henry County, I found three mowers at least forty years old in one community. All three were still in operating condition.

Very often I found a farmer having trouble with his dump hay rake. The rake would leave a strip about 3 or 4 ft wide unraked each time it dumped, or it would dump too quickly. Only a small per cent of the rake owners had ever done anything to regulate the time of dumping, yet most rakes are equipped with some means for making adjustments.

Disk harrows are used on most of the farms visited, and the farmers in Claiborne County seem to have more trouble with the tongue truck than any other one part of the harrow. However, a large number of farmers are neglecting the wood bushings on their horse-drawn harrows, and as a result they have to pay several dollars for castings which the spools have worn through, just because the bushings were not replaced when they became worn. One dealer stated that last year a farmer purchased a new set of castings from

Presented before a meeting of the Tennessee State Section of the American Society of Agricultural Engineers at Knoxville, October 20, 1939. The author is instructor in agricultural engineering, University of Tennessee and served as assistant extension agricultural engineer June 1 to September 15, 1939.

him and put them on without the wood bushings. Before the season was over the farmer was back to buy another set of cast bearings, and this time he bought the wood bushings too.

In Hardin County, I saw a new combine standing in the field where the farmer had left it after giving it a try-out when he purchased it three months previous to my visit to his farm. The machine was weather worn and some of its parts were very rusty. Most of the farmers who have machinery sheds leave a part, if not all, of their machinery out in the weather from four to eight months a year. Of all the farms visited I found less than ten farmers who keep all their machinery under the shed when not in use. One of this group of less than ten states that his grain drill is at least 52 years old.

COOPERATION AND INTEREST SHOWN BY FARMERS

In one county the farm list worked out by the county agent and his assistant was so well planned that I succeeded in contacting every farm listed except two, and I took a record on one of these farms as the owner's son was present to give me the information which I sought.

During the fourteen weeks I was in the field, I made out lists of repair parts needed for more than twenty mowers. These lists were made out at the request of the owners of the machines and handed over to them so that they would be sure to get all parts needed in repairing their mowers.

The number of farmers registering at the seven mower repair demonstrations ranged from 37 to 127, with an average of over 77. Some drove 70 miles on the round trip in order to attend the demonstration.

One farm machinery dealer stated that he sold over $65 worth of mower parts that day to farmers who had attended my repair demonstration. Another well-established dealer stated that he sold more machine repair parts during one week while I was in that county than any other week since he had been in business.

Such statements made by farm machinery dealers in different counties should be sufficient to show that there is a definite interest among the farmers in machinery repair work.

Machines Needed. As to farm machines needed in Tennessee, although Bledsoe County is primarily a livestock county, I found an average of only one manure spreader on every ten farms visited. In my opinion there is a field for a good, low-priced manure spreader in the state. There are still comparatively few lime spreaders in use. Although a large number of the trailing type built on an old auto rear axle are being made, the number of lime spreaders is far too few when we consider the tons of lime spread each season. The farmers of West Tennessee are asking for a contour seeder with three or more openers to take the place of the one-furrow seeder now in use.

Here are some of the things our survey shows that farmers can do to get better service from farm machines:

1 Farm machinery manufacturers supply trade literature with each machine sold, and the farmer should study the literature on each machine purchased, since it gives information on adjustments, care, and operation.

2 A repair parts list is furnished with each new machine sold, and the purchaser can save himself and the dealer time and trouble by keeping this list in a convenient place for looking up numbers on broken or wornout parts.

3 The life and efficiency of most farm machines can be increased considerably by proper housing.

4 Plow moldboards, harrow disks, etc., should be cleaned and oiled before storing.

5 The farmer can make considerable savings on gas and oil alone, to say nothing of time, by purchasing fifty or a hundred assorted bolts, nuts, and washers and having them available when one is needed.

6 Much time and expense can be saved by checking farm machines and making minor adjustments and repairs which often eliminate excessive wear or even breakage of some major part. Very often this could be done on a rainy day if shelter is available.

7 Very few machines are damaged by the use of too much grease, but excessive wear is often caused by the lack of grease or by the use of oil containing metal filings. If used crankcase oil is to be used for oiling bearing surfaces on farm machines, it should be strained through two or three thicknesses of cheese cloth.

Following are some of the services needed by farmers:

1 Every farm machinery sales department should have an alert wide-awake service man who knows machinery.

2 As one county agent states, farm machinery care, repair, and maintenance should be a supporting column in every long-time county or state agricultural program.

3 Plans should be available for farm machinery sheds for various size farms.

4 Every student in a college of agriculture should have some course dealing with machinery at some time during his four years in college. Just last week one freshman in college, who had lived on a farm all of his life, pointed to a two-horse riding cultivator and asked, "What kind of a thing is that?"

Causes of Failure in Tile Drains

(Continued from page 18)

Physical Structure of the Soil. Probably the only method of approach to this problem would be experiment and research by state experiment stations, where the lack of drainage due to this cause constitutes a considerable problem in the general scheme of agriculture.

ACKNOWLEDGMENTS: The author desires to acknowledge the valuable assistance given by the superintendents and engineers of the following CCC drainage camps: D-2 at Defiance, D-3 at Findlay, and D-6 at Delaware, Ohio. It is through their cooperation in making careful inspections and studies of their repair work that this analysis of tile failures is made possible.

Discussion by Dalton G. Miller*

FELLOW A.S.A.E.

MORE trouble has been experienced with clay tile in Minnesota through the use of clays unsuitable for the manufacture of high-grade clay products than for any other reason. At one time there were some 135 plants making brick and tile of Minnesota clays, while at present there are only a dozen or so operating, and the others have gone out of business chiefly because of inferior raw materials. Minnesota has deposits of very fine clays, but the known workable ones are limited.

Poor quality concrete tile will not satisfactorily resist the action of high-acid peats, nor have they satisfactorily resisted the action of certain high-acid mineral soils. Resistance to these agencies may be greatly increased by selecting cements of highest resistance, by the use of rich mixes, and by properly controlled steam curing at temperatures upward from 212 F. In the matter of selection of the cement, concretes made of standard portland cements of highest resistance have been shown to last ten times as long as concretes made of cements of low resistance for identical conditions of exposure to soil alkalies. This difference is less for acid exposure, but tests now under way indicate some cements may resist soil acids twice as well as those of least resistance.

*Mr. Miller is senior drainage engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture.

A Soil Packer Grass Seeder

By F. W. Duffee
FELLOW A.S.A.E.

A METHOD of seeding between the rolls of a double-roll soil packer or corrugated roller was first suggested by George M. Briggs of the agronomy department of the University of Wisconsin, and then developed by A. R. Albert of the Hancock Branch experiment station, which is located in the sandy soil area of central Wisconsin. Its success in that light soil led to its consideration for heavier soils.

Greenhouse trials of grass seed mixtures sown on the surface and at depths of ½, 1, 1½, and 2 in on Miami silt loam and Carrington silt loam show that by far the best stands are secured with surface seeding and seeding ½ in deep.

The figures in Table 3 represent the per cent of all seeds planted that grew.

From these tables it is observed that, with a few minor exceptions, the ½-in depth of seeding equalled or excelled all others.

These tests show rather conclusively that where grass seed is sown 1½ in deep only about one-fourth of the seed will produce plants; exceptions being alfalfa, sweet clover, and commercial bromegrass, and here the ½-in depth is as good or better.

Presented before the Power and Machinery Division at the annual meeting of the American Society of Agricultural Engineers at St. Paul, Minn., June 21, 1939. The author is professor and head of the agricultural engineering department, University of Wisconsin.

TABLE 1. EFFECT OF DEPTH OF SEEDING OF VARIOUS GRASSES AND LEGUMES ON STAND (CARRINGTON SILT LOAM) (HIGH IN ORGANIC MATTER) 1937-38

Species	Per cent of seed sown that established plants from various seeding depths				
	Surface	½ in	1 in	1½ in	2 in
Kentucky bluegrass*	64	68	43	6	9
Redtop	74	73	36	3	0.3
Timothy	93	93	84	40	13
Alsike clover	57	63	57	10	4
Red clover	68	64	68	23	13
White clover	81	81	45	3	0
Alfalfa	80	76	68	52	24
Sweet clover	62	62	55	34	14
Commercial bromegrass	70	80	75	60	35

*Minimum significant difference between means at 5 per cent level —15.8

When the planting was at the 2-in level, a very small percentage survived.

In general, it can be said that for these soils and under greenhouse conditions, planting grass seed 1½ to 2 in deep will mean that the majority of the seed will be buried permanently. The stand will be very thin.

The stand was considerably lower on the Miami silt loam (low in organic matter) than in the Carrington silt loam (high in organic matter). The averages for all species are shown in Table 3.

Greenhouse tests indicate the great advantage of surface or of shallow planting. Experience would indicate that for field conditions surface seeding would probably survive well in a wet year but not in a dry year. We would expect that compacting the soil around the shallow planted seed would also be advantageous. The double-roll soil packer is an excellent implement to accomplish this purpose. The front roll produces corrugations or shallow furrows into which the seed is dropped. The back roll covers and compacts. Where the soil is apt to bake, a chain is dragged behind.

Field trials were begun on the heavier soils at Madison in 1938, which included (1) grain drill adjusted to drop the seed (a) through the seed tube (b) in front of the fur-

TABLE 2. EFFECT OF DEPTH OF SEEDING OF VARIOUS GRASSES AND LEGUMES ON STAND (MIAMI SILT LOAM) (LOW IN ORGANIC MATTER) 1937-38

Species	Per cent of seed sown that established plants from various seeding depths				
	Surface	½ in	1 in	1½ in	2 in
Kentucky bluegrass	42	61	28	0.3	0.1
Redtop	68	66	25	0.2	0
Timothy	58	91	55	7	0.9
Alsike clover	0	19	16	2.3	2.3
Red clover	4.6	26	5.7	0	0
White clover	18	33	8.4	0	0
Alfalfa	9.6	58	72	58	16
Sweet clover	9	35	46	34	2.7
Commercial bromegrass	18	87.5	80	61.5	40

TABLE 3. AVERAGE STANDS AT DIFFERENT DEPTH OF SEEDING

	Depth of seeding				
	0 in	½ in	1 in	1½ in	2 in
Carrington silt loam (high organic)	72.0	73.0	59.0	26.0	12.5
Miami silt loam (low organic)	25.0	52.9	34.0	18.1	7.0

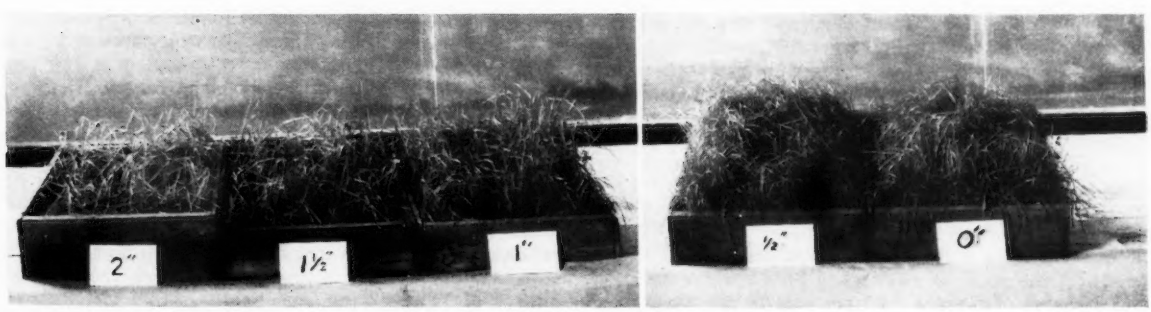
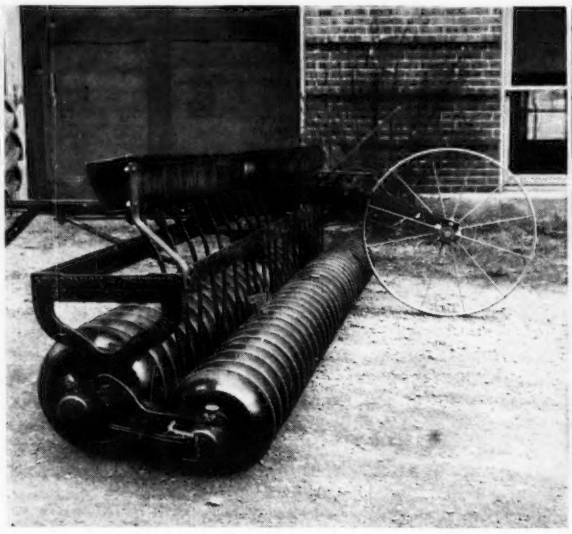


FIG. 1 GROWTH RESULTING FROM GRASS SEED MIXTURES PLANTED AT VARIOUS DEPTHS IN CARRINGTON SILT LOAM SOIL IN GREENHOUSE FLATS



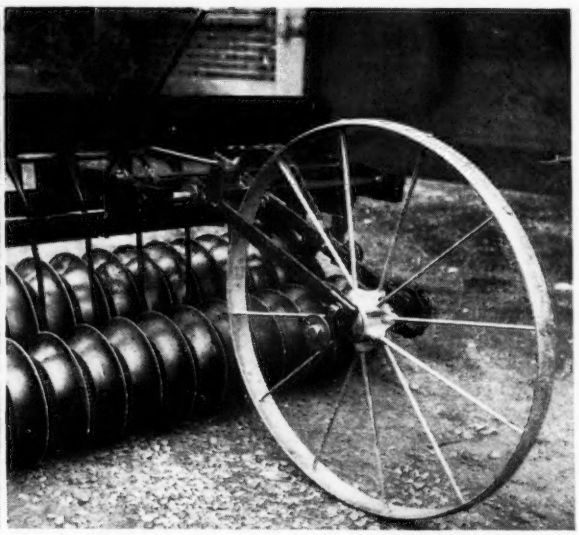


FIG. 2 (LEFT) A SOIL PACKER GRASS SEEDER 10 FT WIDE AND USING A REGULAR GRASS-SEED HOPPER FROM A 20x6-IN DRILL. FIG. 3 (RIGHT) CLOSE-UP OF GROUNDWHEEL MECHANISM WHICH DRIVES THE SEEDER SHAFT AT APPROXIMATELY THE SAME SPEED AS WHEN MOUNTED ON THE DRILL. THE UNIT IS THROWN OUT OF GEAR BY RAISING THE GROUND WHEEL

row openers (c) back of the furrow openers, (d) back of the furrow openers and later packed; (2) (a) a new soil packer seeder, (b) an old, badly-worn soil packer seeder, and (c) an experimental soil packer seeder in which the packer rolls were 2 in wide with corrugations 1¼ in as compared to the standard packer with rolls 4 in wide and 2 in deep. A chain was dragged behind the packer on some of the plots.

Part of each plot was seeded to oats and part was left fallow. Counts on random areas were made at various times during the season, which was very favorable due to rather frequent rains. A mixture of alfalfa and timothy was used.

CONCLUSIONS FOR 1938

1 Initial plant counts made in the field during the period June 20 to 22 indicated that there were no differences in stand due to the various types of soil packers used, or ways in which the different packers were used.

2 Dropping the seeds of alfalfa and timothy down the spouts of the grain drill reduced the stand of alfalfa 29.4 per cent and of timothy 35.5 per cent in the area not seeded to a nurse crop. Dropping the seed in front of the furrow openers of the grain drill reduced the stand of alfalfa 17.6 per cent and timothy 15.4 per cent. A similar condition was found to exist in the area seeded to a nurse crop where dropping the seed down the spouts of the grain drill reduced the stand of alfalfa and timothy 30.4 and 35.7 per cent, respectively. When the seed was dropped in front of the furrow openers, the stand of alfalfa was reduced 26.1 per cent and that of timothy 25 per cent.

3 When the seed was dropped behind the furrow openers and either harrowed or packed into the soil, the stand was not appreciably different than the average of all soilpacker methods.

4 The results obtained under field and greenhouse conditions during 1937-38 would appear to indicate that a material saving of seed (20 to 30 per cent) can be effected through an improved seeding technique.

5 Counts made during the period June 20 to 22 indicated that the stand of alfalfa had been reduced 25.5 per cent and that of timothy 53.5 per cent by the nurse crop. Similar counts made during the period August 10 to 17, following the removal of the nurse crop, showed that the stand of alfalfa and timothy had been further reduced to 37.2 and 66.3 per cent, respectively, by the nurse crop.

The field trials for 1939 are under way, and while no specific data are available, observations are that the soil-packer method will show a still greater advantage over the grain drill method, due to a less favorable season.

Farmers report much better stands with even less seed than they formerly used when seeding with the grain drill. Excellent stands are obtained with 9 to 10 lb of seed per acre when planted with the soilpacker seeder as compared to seeding rates of 15 to 20 lb when seeding with the drill.

Part-time Farming Analyzed

CITY families planning to move to the country and make part of their living from the land, shouldn't make the change unless they are willing to do the farm work for about 13 cents an hour.

This is one of the conclusions reached by Dr. M. E. John, assistant professor of rural sociology at the Pennsylvania State College, following a survey of part-time farming in six industrial areas of Pennsylvania.

"Part-time farming makes economic contributions to certain classes of people," he states. "This is particularly true of large families having a large amount of labor that otherwise cannot be marketed. The major contribution of a part-time farm is the production of food for home consumption. Here again the large family benefits because of the greater need for such food."

Because of the low monetary value of the labor expended on a part-time farm, it is not economically sound to use any labor on the farm that can be employed in industry, Dr. John found from his survey.

"Families most like to succeed on a part-time farm are those in which either the husband or wife once lived in the country," he points out. "This is true of approximately 90 per cent of the families earning part of their living from a farm. Unless a family has a desire to live in the country, chances of success there are slight."—*From Agricultural Leaders' Digest. November 1939.*

Progress in Farm Storage of Corn

By William McArthur

THE PRACTICAL and technical advice of agricultural engineers is evidenced in the thousands of improved corn storage structures which have been erected this year on corn belt farms and the steel-bin storage which bears the "Ever-Normal" sign at hundreds of country points.

Commodity loan programs, the "backbone" of the ever-normal granary, enable farmers to withhold the surplus from good crop years until needed in times of short crop years. They make possible the orderly marketing of crops at a fair price, while financing farming operations at a low rate of interest. By means of the corn loan programs, the high yields of recent years have resulted in higher incomes to farmers, whereas formerly such yields have resulted in ruinously low prices and overexpansion in livestock production.

The 1939 corn loan program will enable farmers to benefit from the high yields of 1939 and still avoid greater overexpansion in livestock. This year we have more eligible borrowers and more eligible corn than at any time since 1933, and the largest carry-over of corn in history. This in itself presents a problem in obtaining sufficient eligible storage space. Farmers should also realize that, if stabilization of supplies and prices is to be maintained through the loan program, future plantings need to be adjusted until crops are more nearly in balance with normal domestic consumption and exports.

With an ample supply of corn in the ever-normal granary, farmers will protect their incomes most effectively by planting within the agricultural conservation program allotments in 1940 and devoting a greater portion of their land to soil-conserving crops. Conservation, as well as adjustment, is required in any stable plan to protect farm income.

With its abundant natural resources, this nation could have built an ever-normal granary long before, but instead we have exploited the soil and suffered from low incomes. Farmers acting individually were unable to deal effectively with their national problems. They now have the means to cooperate in obtaining both conservation and adjustment.

CORN STORED CLOSE TO AREA OF PRODUCTION AND USE

Through the ever-normal granary, farmers are offering protection to consumers and livestock producers in return for the protection they have under the farm program. If the ever-normal granary is to afford this protection in the future, farmers need to emphasize conservation and adjustment to a greater degree, particularly in times of abundant supplies.

Participation in the corn loan program, as well as in the agricultural conservation program, is voluntary. For this reason we should all cooperate in helping farmers to understand and carry out all phases of these programs, if a program of abundance is to be a blessing instead of a disaster.

Unlike wheat, the bulk of the nation's corn crop is normally marketed in the form of meats, eggs, and dairy products. About 85 per cent of a normal year's corn crop is fed to livestock. Therefore, the success of the ever-normal granary plan for corn depends largely upon storing the corn on or near the farm where it is produced and fed.

The real effectiveness of the ever-normal granary for corn depends upon the proportion of surplus corn which the farmer can store on his farm or at country points without excessive storage and transportation charges accruing against it. If the ever-normal granary can be entirely retained in the country, eventually it will flow through the regular channels, without endangering corn prices or livestock supplies.

Resealing programs for corn are basic to the ever-normal granary. Through resealing programs it is possible to increase the carry-over of corn to a point where it will be really effective in smoothing out price and supply fluctuations for corn belt agriculture. Farmers who renewed their loans and stored their corn for an extra year are eligible to earn a storage allowance of 7 cents per bushel. This payment was advanced to them at the time of the loan renewal, if they needed it to help build additional bins or cribs.

CORN STORAGE STRUCTURE REQUIREMENTS

Since the inauguration of the corn loan program six years ago, wonderful progress has been made in the design and construction of suitable farm storage structures for corn. Each year farmers are increasing their storage facilities with cribs and granaries which are better designed for the proper conditioning and preservation of the corn collateral in the respective areas.

Under the corn loan program we have had an opportunity to observe the actual merit of different types of crib structures. We have found that the widths of a crib and facilities for proper ventilation are important in areas of high humidity. We have also found that long-time storage of corn brings out many structural defects in cribs, such as poor foundations, and insufficient bracing of walls which are not substantial enough to withstand the tremendous pressure of dry corn. Certain types of roofs are also susceptible to damage from weather and rodents. Comparatively inexpensive types of cribs have been designed, built, and used, which have proved to be satisfactory types of storage for ear corn. The most recent type of ear corn storage is a radical departure from the conventional slatted crib, namely, a vertically ventilated storage. This type is still in the experimental stage, but under certain circumstances has great possibilities, particularly in that it can be easily made rodent-proof and may make possible the fumigation of the corn against insect hazards. It also has the advantage of permitting conditioning of the corn during favorable weather and better protection of the corn in bad weather.

Corn stored in vertically ventilated, tight-walled storage structures will be acceptable for loans subject to the following conditions:

1 The structure is a separate unit located where there is a free circulation of air from all directions.

2 It has a secondary slatted bottom at least 8 in above the solid bottom, which permits air to circulate upward through the corn.

3 The roof is equipped with an effective rotary or

Presented before the Farm Structures Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 5, 1939. Abridged. The author is chief of the Commodity loan and crop insurance section, north central division, Agricultural Adjustment Administration.

syphon ventilator, and the structure has an adequate air inlet under the grate floor which can be closed in bad weather.

4 The depth of corn in such a structure is no greater than the recommended crib width for the county in which the structure is located and the moisture content of the corn does not exceed 18½ per cent.

5 In case the depth of corn is greater than the recommended width for the county, the corn will be acceptable for loan provided the moisture content of the corn is one-half per cent less than 18½ per cent for each additional foot in depth.

Under the liquidation program for 1937 corn a year ago, producers were permitted for the first time to shell their corn collateral and reseal it in tight granaries for a loan extension. Nearly nine million bushels were stored the past year in this manner. This corn was stored in steel bins and in wooden granaries of many types. The only losses experienced were due to faulty structures, leaky roofs, or to dirt and trash stored with the corn which had not been removed by the shellers. Last year's program proved that where corn had been thoroughly conditioned in crib storage, and was shelled with a moisture content under 13½ per cent, it could be safely stored for the additional year provided the storage structure is tight enough to prevent the corn from taking up excessive moisture. Such storage is also practicable for the storage of corn in areas subject to insect hazards, provided it is given proper supervision and the corn is fumigated promptly upon discovery of insects. Under this year's liquidation program, this type of storage is being used far more extensively by producers for storing their corn collateral under loan extensions for the coming year.

LOCAL STORAGE FACILITIES SUPPLEMENTED BY STEEL BINS

In some cases farmers were not able, because of insecure tenure and other reasons, to reseal their corn either on their farms or in local elevators. This corn was delivered to the Commodity Credit Corporation in settlement of the loans.

To retain this corn out in the country as a part of the ever-normal granary, it was necessary to store it as near as possible to the place where it is produced. Consequently, the government purchased steel grain bins to place at country points for storage of the corn. Only corn which farmers could not store either on their farms or in local elevators and which was delivered in settlement of the loans, was stored in the government bins.

Storage in these bins will not only keep the corn out in the locality where most of it will eventually be fed to livestock, but it will also represent a considerable saving on storage charges.

It is estimated that the cost of two years storage in government steel bins will be less than the cost of storage in commercial warehouses. When the steel bins have saved in storage charges an amount equal to their cost, they will become the property of the county agricultural conservation associations and will be utilized thereafter in accordance with instructions from the Agricultural Adjustment Administration.

The trade also has a stake in the resealing program. Every bushel of government-owned corn which is permitted to leave the local shipping point becomes a disturbing factor to normal marketing procedure. Warehousemen, grain commissionmen, transportation agencies, and inspection services should cooperate in effectuating the ever-normal granary in order that corn marketing may flow through normal channels.

All corn stored in these bins will be held until it is needed on farms for livestock feed or until higher corn prices justify its movement into regular channels.

Approximately 1850 country elevators with available storage for 38,000,000 bushels of corn were approved by Commodity Credit Corporation under this year's corn liquidation program. The greater portion of this space was utilized either for the storage of corn collateral by borrowers for loan extension or the storage of corn delivered to the government in payment of loans. In all cases the approved local storage was filled before any steel bins were set up for the storage of government corn.

Wherever satisfactory arrangements could be made, the county committees have contracted with local elevators for the erection and the storing of government corn in the steel bins. For this service the local elevator was usually paid from 2½ to 3 cents per bushel for the amount of corn stored. When corn prices advance above the loan value, it is contemplated that arrangements will be made for such elevators to handle the liquidation in order that the corn may move through normal marketing channels.

VARIED STORAGE EXPERIENCE PROVIDES TEST OF STRUCTURES

We now have the greatest opportunity in history to compare the relative merits of different classes of storage. We have farm storage for both ear and shelled corn, steel bin storage, country elevator storage, subterminal and terminal warehouse storage. Then within classes we can compare many different types of corncribs and granaries, different kinds of construction in steel bins, and different sizes and kinds of bins and facilities in connection with elevators.

We still have much to find out about the most desirable types of storage structures from the standpoint of conditioning corn, preserving corn, and protection against weather, rodents, and insects. Probably the greatest problem that we have at this time and which is causing us the most concern is the insect problem. The angoumois moth which is prevalent in the southern part of our commercial corn areas, and other insects such as rice weevil, granary weevil, sawtooth grain beetle, and Indian meal moth are the insects causing the damage. Apparently there is a cycle for insects and we are now in the worst stages of that cycle. State entomologists have given us the best of cooperation in helping to control this insect hazard.

We started this corn marketing year October 1 with the largest carry-over in history and a total supply of 3,152,000,000 bushels of corn. In spite of this huge supply, the ever-normal granary is becoming effective. We have already restored under seal on farms, in steel bins and elevators, 250,000,000 bushels. It is estimated that at least another 250,000,000 bushels will be sealed this winter under the 1939 corn loan program. Furthermore, we are probably conservative in estimating that at least another 250,000,000 bushels will be held privately by farmers who do not need the money and who consistently every year carry a reserve supply of corn. This makes a total of at least 750,000,000 bushels of corn which will be held off the market and from feeding until the end of the marketing year, if the price is not satisfactory, thereby reducing the supply of corn to well under what we will actually need for domestic consumption and export. The wonderful thing about this program is that we have built this huge ever-normal granary for corn without a large acreage in corn and without the tremendous depreciation of our soil fertility which has occurred sometimes in the past when we produced surplus crops. In addition to this we have planted more of our land to soil conserving crops and are building an ever-normal granary in the soil as well as a visible ever-normal granary.

Transport Wheels for Agricultural Machines

III. Effect of Inflation Pressure on the Rolling Resistance of Pneumatic Implement Tires

By Eugene G. McKibben and J. Brownlee Davidson

FELLOW A.S.A.E. CHARTER A.S.A.E.

SUMMARY

1 Inflation pressure is one of the most important factors affecting rolling resistance of pneumatic implement tires.

2 Reducing the inflation pressure increases the work of flexing the tire but decreases the energy expended in displacing the soil.

3 On a hard smooth surface such as concrete, where there is no surface displacement, reducing the pressure therefore increases the rolling resistance.

4 On an intermediate surface, such as a bluegrass pasture, changing the inflation pressure has relatively little effect.

5 At the other extreme, such as loose sand, reducing the pressure greatly decreases the rolling resistance.

6 Thus, if an agricultural machine is to be operated intensively on soft, loose surfaces, the use of larger capacity tires which permit lower inflation pressures may be justified on the basis of power economy.

INFLATION pressure is one of the dominant factors affecting the rolling resistance of pneumatic implement tires because this pressure controls the extent to which the tire is flexed and the degree to which the soil is compacted.

Tires. Two tires, a four-ply 6.00-16 and a four-ply 7.50-28-in, were used in studying the effects of inflation pressure (Fig. 1). The former was selected because of its extensive use on light and medium-weight machines, and the latter because it was the largest tire which could be tested up to capacity with the equipment available.

Equipment and Field Conditions. The equipment used in this phase of the investigation was shown in Figs. 2, 3, and 4 of article II of this series[1]. These figures also show the field conditions which are described in detail in Tables 1 and 2 of the same article.

Loads. The smaller wheel was tested at 500, 1000, and 1500-lb loads. Although the 1500-lb load exceeds the capac-

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The authors are, respectively, associate professor of agricultural engineering, and professor and head of the department of agricultural engineering, Iowa State College.

FIG. 1 6.00-16-IN AND 7.50-28 IMPLEMENT TIRES USED TO OBTAIN THE DATA IN TABLE 1

[1] McKibben, Eugene G., and Davidson, J. Brownlee. Transport wheels for agricultural machines: II. Rolling resistance of individual wheels. AGRICULTURAL ENGINEERING 20:469-473 (December 1939).

TABLE 1. ROLLING RESISTANCE[a] OF 6.00-16 AND 7.50-28-IN IMPLEMENT TIRES AT FIVE INFLATION PRESSURES AND THREE LOADS ON FOUR ROAD AND FIELD CONDITIONS[b]

Tire size	Load, lb	Pressure,[c] lb sq in	Reduction in radius, in[d]	Field Condition[b] A—concrete	B—bluegrass	C—tilled loam	D—loose sand
6.00-16 4-ply	500	10	1.5	18	29	139	130
		15	0.9	17	28	150	143
		20	0.8	16	29	160	154
		30	0.7	14	30	165	156
		40	0.6	13	31	164	163
	1000	10	2.6	40	62	239	226
		15	1.7	30	57	297	281
		20	1.3	27	60	319	338
		30	1.0	22	64	345	397
		40	1.0	23	63	354	410
	1500*	10	3.7	96	98	337	361
		15	2.4	48	82	391	401
		20	2.0	41	83	433	479
		30	1.4	34	84	503	584
		40	1.3	32	90	532	626
7.50-28 4-ply	1000	10	1.8	28	53	182	179
		15	1.5	23	55	208	207
		20	1.2	22	57	218	211
		30	0.9	16	60	223	235
		40	0.8	16	54	231	238
	1500	10	2.5	49	81	266	259
		15	1.9	39	78	296	308
		20	1.4	35	79	329	348
		30	1.2	29	82	358	394
		40	1.0	26	86	380	408
	2000	10	2.8	72	109	307	347
		15	2.2	61	91	336	421
		20	1.7	47	91	372	495
		30	1.4	43	99	405	562
		40	1.2	41	106	423	583

[a] Each value is the mean of three non-consecutive tests. The pooled standard error of these means are 2.2, 3.8, 4.2, and 8.9, respectively, for concrete, bluegrass pasture, tilled loam, and loose sand.

[b] Soil conditions are described in detail in Tables 1 and 2 of article II of this series, Rolling Resistance of Individual Wheels. AGRICULTURAL ENGINEERING 20:469-473 (December 1939).

[c] Recommended capacities are 1240, 1520, and 2010, respectively, for four-ply 6.00-16, six-ply 6.00-16 and four-ply 7.50-28-in tires, and the corresponding inflation pressures are 28, 40, and 24 lb, respectively.

[d] From unloaded radius, reduction measured while supporting load on concrete road.

* Exceeds the recommended capacity of a four-ply 6.00-16-in tire by 260 lb.

ity of a four-ply 6.00-16-in tire, it was included because it is approximately the capacity of a six-ply tire of the same size. The rolling resistance data obtained at this load are probably about the same as if a six-ply tire had been used. This limited investigational operation at an overload should not be interpreted, however, as a recommendation for the extensive field use of such overloads.

The larger tire was tested at 1000, 1500, and 2000-lb loads. The 2000-lb load is approximately the capacity of both the tire and the testing equipment.

Results. The results obtained with both tires on concrete and three field conditions—bluegrass pasture, tilled loam, and loose sand—are given in Table 1. The data for the smaller tire are also shown graphically in Figs. 2 and 3. If the values for the larger tire are plotted according to the same plan similar graphs are obtained.

Concrete. On concrete, increased pressures resulted in appreciable decreases in rolling resistance. The operator is cautioned, however, against the use of excessive pressures in light tires, particularly where operating over rough, rocky surfaces.

Bluegrass Pasture. On the bluegrass pasture the effect of changing inflation pressure was relatively small. Apparently the decreased soil displacement which accompanies reduced pressure was about balanced by the increased flexing of the tire which also accompanies reduced inflation pressure. This was particularly true at the 1000-lb load. It is interesting to note that, for this particular field condition, the ends of the pressure-rolling resistance graph turn downward at the 500-lb load and upward at the 1500-lb load.

Tilled Soil and Loose Sand. On both the tilled soil and loose sand, reducing the inflation pressure greatly reduced the rolling resistance. This effect is most noticeable on the loose sand at the heavier loads. In fact, for these extreme conditions, the gain resulting from reduced inflation pressures is sufficient to be of considerable economic importance. In the case of a 1000-lb load, reducing the pressure from the recommended 20 lb to 15 lb decreased the rolling resistance about 17 per cent, and a further reduction in pressure to 10 lb resulted in a 33 per cent decrease in rolling resistance. There are emergency situations where these decreases in rolling resistance may justify the tire abuse which results from such underinflation.

Greater Tire Capacity. If, however, an agricultural machine is to be intensively used on extremely loose surfaces, the feasibility of using larger tires or a greater number of tires should be carefully considered. Either plan permits lower inflation pressures without undue flexing of the tires.

For example, if, on the loose sand, a 2000-lb load were carried on four 6.00-16 tires at 10-lb inflation pressure, rather than on two such tires at 20-lb pressure, the decrease in rolling resistance would be 23 per cent, or 156 lb. At 5 mph this reduction amounts to 2 hp. If such a situation should exist for 100 hours per year and a round figure of 5 cents is assumed as the cost per drawbar horsepower-hour[2], the annual saving in power cost resulting from the use of the two additional tires would be $10.00.

The same procedure might be applied to the possibility of using two 7.50-28-in tires at a 10-lb inflation pressure. In this case the reduction in rolling resistance from two 6.00-16-in tires at 20-lb pressure is 47 per cent, or 318 lb. Using the same assumptions as above, the annual reduction in power cost would amount to $21.00.

[2]Goodsell, W. D. Cost and utilization of power and labor on Iowa farms. Res. Bul. No. 258, Iowa Agr. Exp. Sta. 1939.

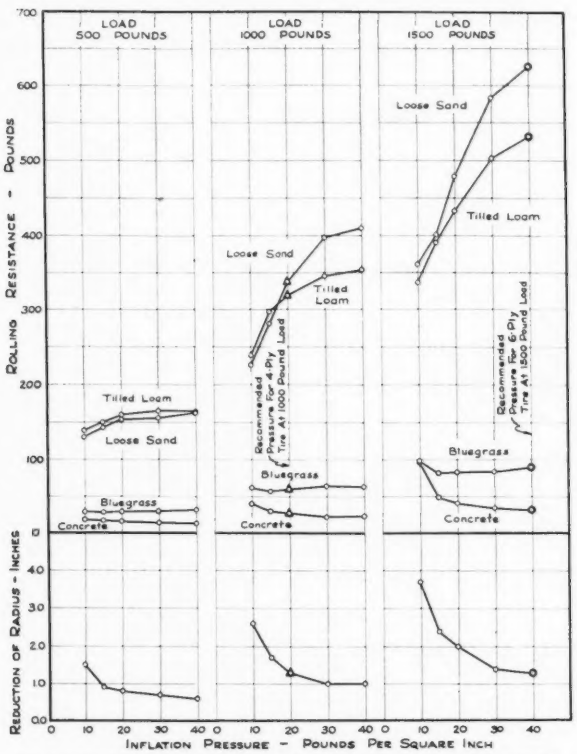

LOAD 500 POUNDS
LOAD 1000 POUNDS
LOAD 1500 POUNDS
Loose Sand
Tilled Loam
Bluegrass
Concrete
Recommended Pressure For 4 Ply Tire At 1000 Pound Load
Recommended Pressure For 6 Ply Tire At 1500 Pound Load
ROLLING RESISTANCE - POUNDS
REDUCTION OF RADIUS - INCHES
INFLATION PRESSURE - POUNDS PER SQUARE INCH

FIG. 2 ROLLING RESISTANCE OF 6.00-16-IN IMPLEMENT TIRE AT DIFFERENT INFLATION PRESSURES FOR THREE LOADS ON FOUR ROAD AND FIELD CONDITIONS. SIMILAR GRAPHS ARE OBTAINED IF THE DATA FOR THE 7.50-28-IN TIRE GIVEN IN TABLE 1 ARE PLOTTED IN THE SAME WAY

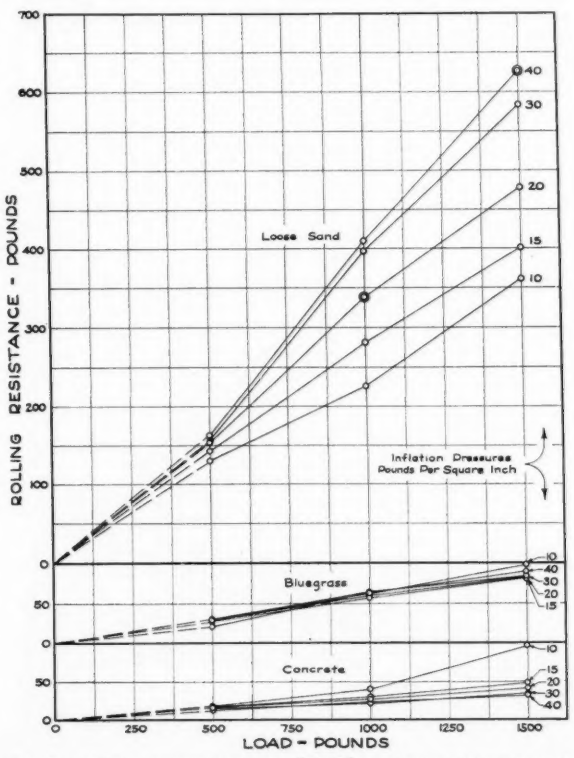


FIG. 3 ROLLING RESISTANCE OF 6.00-16-IN IMPLEMENT TIRE AT DIFFERENT LOADS FOR FIVE INFLATION PRESSURES ON THREE ROAD AND FIELD CONDITIONS

The Agricultural Engineer's Interest in Small Items of Prefabricated Structural Farm Equipment

By D. H. Malcom
JUNIOR MEMBER A.S.A.E.

BY "small items of prefabricated farm equipment," I refer to such products as stock tanks, sprayers, poultry equipment, barn equipment, hog waterers and feeders, storage tanks, well casings, and other items of miscellaneous equipment which are found around the farm and which collectively represent a large industry. It takes only a casual glance to see the tremendous size of the industry which makes these smaller items of farm equipment.

According to Milliards' directory, there are fifty-five manufacturers engaged in making stock tanks alone, and of course there are small shop manufacturers who are not listed. In addition to this, a large number of tanks are manufactured on the farm from wood, concrete, or metal. Thousands of men are employed in designing, producing, and selling these tanks. There is more to making a stock tank than bending a sheet of metal into a circle, nailing some boards together, or pouring concrete into a form. The height of the sidewall, its strength, and the type of joint must be considered. Figuring ways of meeting the necessary requirements at minimum cost is a good problem for any agricultural engineer.

POULTRY EQUIPMENT IS BIG BUSINESS

Another example is the poultry equipment industry, which has literally grown up around us in the past few years. During even the short space of time since I was on the farm, the life of the hen has changed marvelously, and I predict that the next few years will see an even greater change. Ten years ago poultry was a necessary evil to general farming. Today poultry is a major farm enterprise in many sections of the country. The chick no longer runs behind the hen, but is warmed by an electric brooder, fed and watered by automatic waterers and feeders, while the hen has been taken out of her motherly role and placed in an individual cage where she produces eggs, or goes into the stewing pot. More than fifty manufacturers design, build, and sell millions of dollars worth of poultry equipment annually. Even such seemingly foreign products as sheet rubber are used in carload lots by many manufacturers. The design and sale of this poultry equipment is really a job for a good agricultural engineer. If the radius at the bottom of a watering pan is $\frac{3}{4}$ inch, there is a reason for it. If the bottom of the pan is stamped straight up under the slip-on top and then spun out, that also is for a purpose; and if the pad of the brooding part of the battery brooder is made of soft material for contact with the chicks, the designer of course had his reasons for it.

I believe it will be agreed that one who studies the nature of farm animals and designs equipment to better satisfy their needs is as much an agricultural engineer as the man who studies farm crops and designs machinery to grow those crops, or the man who studies human beings, animals, and nature and designs farm buildings to accommodate them. If you were to investigate, you would find that the design of miscellaneous equipment in many cases is just as difficult as is any other field of agricultural engineering, and if you were to see a buyer of this type of equipment present an order to one company for over $100,000 worth of merchandise, you would agree that it is really big business.

In this paper I have tried to emphasize two points, namely, (1) that this field is truly one for agricultural engineering, and (2) that it is large enough to deserve much consideration from this society.

It is true that no one article is particularly large, but the various allied products are almost as closely related as the various items in the implement line, no one of which, with the possible exception of the tractor, represents a great industry by itself. With this in mind, let us check up on what we, as the official group of agricultural engineers, have done in the way of service to this new field. We have had some good discussions on some of the articles, and in the past this may have been sufficient. However, at present we are really in need of a definite program for this new phase of agricultural engineering, a program which will establish agricultural engineers as leaders in this field.

The next question is, What will be gained by such a program, and is it worth while? It will give all of us a better understanding of the changes that are taking place, and it will also develop some much needed information for the industry as a whole, in the end resulting in our helping to improve general agricultural conditions, which is the goal of every agricultural engineer. In addition, it should help create more jobs for agricultural engineers.

It seems reasonable to say that in a field of several hundred manufacturers who employ thousands of men, and who deal with agricultural problems every day, there are jobs for agricultural engineers—jobs that have plenty future to make them attractive. However, at present the agricultural engineers are not actually well enough trained in this field to get the jobs. Just recently one manufacturer of miscellaneous farm equipment wanted to hire a man for work in his factory. After interviewing a number of college graduates who had no knowledge of the problem, he hired a high school graduate with a couple of years of shop practice. He didn't expect a college graduate to be familiar with the details of his work, but he wanted him to know something of the fundamentals.

DESIGNING EQUIPMENT FOR FARM USE IS AN AGRICULTURAL ENGINEERING JOB

As we become more familiar with the problems in this field, the industry will place more confidence in our standing as agricultural engineers, and give more preference to this group in hiring new men. Of course, it is up to us to decide what we can do to bring about these changes, and here is where I think we can all help. I have a few ideas, and I place them before you merely as suggestions; perhaps they will serve as a basis for further planning.

It seems desirable that a committee be appointed to study this situation and make recommendations at one of our meetings. This committee could act *(Continued on page 29)*

Presented before the Farm Structures Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 6, 1939. The author is agricultural engineer, American Rolling Mill Co.

Terracing Costs and Cost Records

By J. T. Copeland
MEMBER A.S.A.E.

TERRACING costs and cost records were first brought to our attention in Mississippi in 1934 with an accounting service rendered through the cooperative agreement between the Tennessee Valley Authority and the Mississippi agricultural extension service. Under this agreement three county terracing assistants were employed without charge to the county as a part of the campaign for an erosion control program in the Valley. Through this stimulus a power terracing unit was leased to each of the three county terracing associations when 1,000 acres were listed and a deposit of 25 cents per acre posted by the farmers as evidence of good faith. The charge to the farmers for terracing was at the rate of $2.50 per hour of field work. Although this charge did not suffice to prevent breach of lease and the repossession of the equipment, the county terracing reports supplied by the office of J. B. Wilson, extension agricultural engineer of Alabama and T.V.A. coordinator, revealed certain encouraging facts which became the inspiration for a more extensive and intensive state power terracing program.

Mr. Wilson's report, for the 39 watershed counties which participated in the T.V.A. program, revealed an average cost to the farmer of $1.11 per acre in the low-cost county and $2.69 per acre in the high-cost county. The all-county average cost to the farmer was $1.69 per acre. The three Mississippi counties, although varying widely in soil type, degree of erosion, and general topography, showed a low cost of $1.30, a high cost of $1.32, and an average cost of $1.31 per acre to the farmer.

The favorable position of Mississippi in this report is attributed to terrace location, grade, direction, and construction standards[1]. These standards were the premise upon which extension schools and field work were established and from which the state AAA specifications and the private contract terracing units have developed within the state.

In 1938 the Mississippi extension agricultural engineers, through mutual agreement with terracing-unit owners and supervisors, started a cost record and field methods study to secure a safe and satisfactory contract terracing service to the farmer by any cooperating agency. L. O. Palmer, assistant extension agricultural engineer, has obtained the cooperation of 18 of the 29 power terracing units in the state. His most recent report reveals some interesting trends and deductable conclusions. Again terrace costs are influenced most by terrace technique.

In Tables 1 and 2 the private contractor using soil erosion index terracing standards effected an average saving to the farmer over the per cent slope terrace designation by (1) a 3-cent margin per 100 ft of terrace, (2) a 6-cent margin in charge per hour, and (3) a 14-ft gain per hour in terrace footage. These differences are attributed to the fact that the owner supervisor is more interested in his reputation and his future profits, to the extent that he is anxious to deliver a "lock and key job", and to the difference in terrace technique.

Terraces laid out according to the soil erosion index are located either above the gully heads or through their narrow and shallow sections, thereby reducing number and amount of fills required, whereas per cent slope designated terraces usually fall below these erosion points, causing increased number and size of fills and considerable loss of tractor speed. The increased number of terrace lines per slope with the erosion index permits the use of slightly smaller terraces with safety, and these terraces, usually a modification of the ridge terrace and channel terrace designs, are more economical of labor and machines in turning and delivery of soil into an effective terrace.

Closer scrutiny of the records indicates decreased margin of profit to the contract owner due to his labor and repair charge overhead. By observation of the various personal traits, the contractor of mechanical background is able to secure a margin of profit through his own repair shop, but his attitude and way with the farmer is not as satisfactory to the farmer as the owner with farming, or at least a rural, background.

In working with the records and in cooperating with field operators, one's curiosity is aroused as to the future trend of development of power contract terracing. Although the farm background contractor generally presents the best farm terracing service, such operators are jeopardized by cost of repairs and expert service charges. Until terrace machines and tractors are perfected to take charge of this constant-load, heavy-duty job, the contractor without machine shop facilities is apt to suffer from lack of profits.

Presented before the Soil and Water Conservation Division at the annual meeting of the American Society of Agricultural Engineers, at St. Paul, Minn., June 22, 1939. The author is extension agricultural engineer, Mississippi State College.

[1] "Terracing with Copeland's Soil Erosion Index System," Mississippi Extension Bulletin No. 101.

TABLE 1. TERRACE SYSTEM LAYOUT ACCORDING TO PER CENT OF SLOPE, C.C.C. PARTICIPATION*

County	Hours terracing	Million feet of terrace	Feet per hour	Farmer's cost Per hour	Per 100 ft, cents	Total
Benton	2294	1.1	480	$3.00	63	$ 6,882
Kemper	4811	3.0	623	3.75	46	18,041
Lafayette	1491	1.2	805	3.25	39	4,846
Union	1827	1.0	547	3.50	59	6,394
Yalobusha	1395	0.7	501	3.00	57	4,185
Total and average	11818	7.0	606	3.42	57	40,348

*Terrace fills made by the farmer with the terrace drainage outlets, engineering service borne by C.C.C. operations.

TABLE 2. TERRACE SYSTEM LAYOUT ACCORDING TO SOIL EROSION INDEX, PRIVATE CONTRACTOR COOPERATION*

County	Hours terracing	Million feet of terrace	Feet per hour	Farmer's cost Per hour	Per 100 ft, cents	Total
Chickasaw	4198	2.7	643	$3.50	54	$14,693
Okibbeha	1483	1.0	674	4.00	59	5,932
Panola	5558	2.9	521	3.00	57	16,674
Yazoo	2810	2.0	712	3.50	46	9,835
Winston	147	.16	1088	4.00	37	588
Total and average	14196	8.76	620	3.36	54	47,722

*Lock and key job terrace fills completed, terrace drainage provided, and all engineering and tractor labor furnished by contractor.

TABLE 3. POWER TERRACING REPORT FOR MISSISSIPPI, TABULATED FROM RECORDS OF SEVERAL COUNTIES BY AGRICULTURAL ENGINEERING DEPARTMENT OF THE MISSISSIPPI AGRICULTURAL EXTENSION SERVICE

TABLE 3. POWER TERRACING REPORT FOR MISSISSIPPI. TABULATED FROM RECORDS OF SEVERAL COUNTIES BY AGRICULTURAL ENGINEERING DEPARTMENT OF THE MISSISSIPPI AGRICULTURAL EXTENSION SERVICE

		Alcorn (Co. Pur.)	Benton (AAL)	Chickasaw (Private)	Kemper (AAL)	Lafayette (AAL)	Newton (AAL)	Oktibbeha (Private)	Panola (Private)	Pontotoc (Private)	Tippah (AAL)	Union (AAL)	Winston (Private)	Yalobusha (AAL)	Yazoo** (Private)
Acres terraced		2584	3220	5339	6735	2804	597	4599	5379	100	1482	3056	131	2062	3709
Million feet of terrace		1.3	1.1	2.7	3	1.2	0.27	1.0	2.9	0.02	0.97	1	0.16	0.7	2
Time spent in hours	Terracing	2248	2294	4198	4811*	1491	303	1482	5558	32	1446	1827	147	1395	2810
	Other work	676	1045	2100	265	328	30	291	1391	62	588	230	29	41	750
	Road travel	115	77	402	179	130	36	115	300	2	84	68	33	75	100
	Total tractor	3039	3416	6700	4425	1949	369	1888	7249	96	2118	2125	209	1511	3660
Operating cost								$ 995.97	$ 1800.00		$ 488.05	$ 491.41	$ 1.50	$1183.00	$ 1161.94
Total repairs		$ 611.07	$ 1065.15	$ 1611.66	$ 1892.95	$ 581.58									
Labor cost	Terracing		899.82	3684.60	1673.20	292.22	$ 305.80	941.40	3334.80	$ 24.26	1012.00	860.59	107.46	279.00	5620.00
	Other work	1348.80	418.00	1842.30	159.00	98.40	30.16	185.30	804.60	46.87	26.35	106.10	26.10	8.20	750.00
	Road travel	405.60	30.80	378.00	80.55	39.00		71.67	180.00	1.92	68.00	66.74		26.50	200.00
	Greasing	69.00		295.10				59.70	217.00		27.50	64.69			366.00
	Surveying		TVA	1575.00	960.45	SCS	216.05	1680.55	2493.00	SCS	277.93	SCS	110.91	SCS	37.43
	Total	1823.40	1348.62	7775.00	2873.20	429.62	552.01	2938.62	7029.40	73.05	1411.78	1098.12	245.97	313.76	6973.43
Fuel oil		704.19	747.05	1571.80	2014.04	1258.26	95.64	398.08	1781.00	11.40	257.76	537.68	40.60	521.38	622.20
Grease and lubrication		362.33	266.01	895.70	332.10	89.50	44.91	269.35	1381.00	34.42	120.78	206.66	25.37	256.18	549.00
Miscellaneous			415.39	1957.61	258.81			94.25		70.00	33.60	16.74	17.71		
Total operating cost		3500.99	3842.22	13811.77	7371.10	2358.90	692.56	4696.27	11991.40	188.87	2311.97	2350.61	331.15	2274.32	9306.57
Total receipts from all work		6579.00	10017.00	24248.00	19035.00	5912.00	1332.00	7092.00	20847.00	329.00	7119.00	71995.00	704.00	4308.00	12460.00
Farmers' terracing bill		5058.00	6882.00	14693.00	16041.00	4846.00	1212.00	5928.00	16674.00	112.00	5061.00	6394.00	588.00	4185.00	9835.00
Hourly charge		2.25	3.00	3.50	4.00	3.25	4.00	4.00	3.00	3.50	3.50	3.50	4.00	3.00	3.50
Paid on	Tractor and grader	None	3987.00	6312.00	5400.00	2964.00		2120.00	8201.00	1498.00	3425.00	3584.50	946.16	2423.00	7507.00
	Other equipment	None	17.74	None	None	None			55.00	8.55	None	189.22			
Cost to farmer	Per acre	1.96	2.14	2.75	2.07	1.72	2.03	1.41	3.09	1.12	3.41	1.94	4.48	1.92	2.65
	Per 100 ft of terrace	.38	.63	.54	.46	.39	.45	.59	.57	.56	.52	.59	.37	.57	.46
Machinery	Tractor	2 TD-40	1 RD-6	2 Cats.	1 TD-40	AC	1 TD-40	2 RD-6	2 RD-6	1 RD-6	1 RD-6	1 TD-40	1 RD-6	AC	2 RD-6
	Grader	2 Adams	1 No. 2 Cat.	2 No. 2 Cats.	Adams	Aust-West	1 Adams	2 No. 2 Cats.	2 No. 2 Cats.	1 No. 2 Cat.	1 No. 2 Cat.	1 Adams	1 No. 2 Cat.	Aust-West	2 No. 2 Cat.
	Other equipment	1 Dozer	None	None	None		1 Dozer	1 Dozer	2 Scrap.	None	None		1 Dozer	None	1 Dozer

*Private contractor, 830 hr.

**Moved from Yazoo to Oktibbeha, 8-18-38.

Small Items of Prefabricated Equipment

(Continued from page 27)

as a coordinator of the various industries involved and collect educational information for use by the colleges.

One-half day of the Farm Structures Division program might be set aside in the future for the discussion of these allied products. I say the Farm Structures Division program because these products are so closely related to farm buildings that they will fit in well with our general program. For instance, the size of a milk cooler is of direct interest to the man who designs milk houses, and the type of poultry production to be followed is of primary interest to the poultry house designer.

I hope that every agricultural engineering department head in the colleges will carefully consider devoting a few classes (not courses) to these products. I know most of them have a miscellaneous course in the structures curriculum, and that these products would fit into it well and give the student a general knowledge of some of the uses of this equipment and some of the problems encountered in design. I remember a course of this kind I took under Professor Henry Giese, in which we covered furnaces, wiring, sewage disposal, water systems, etc. Naturally, we did not get into the details, but I will say that later, when I happened to visit a water system manufacturer, I knew that there were both deep-well and shallow-well systems and that each had certain advantages under certain applications. In other words, I knew enough of his business so that I could listen intelligently and gather some information from what he was saying.

The points outlined above are only a start. However, they are simple to put into effect, and they will help much to improve the present condition and will serve as a basis on which we can build to become more familiar with this phase of agricultural engineering and ultimately become more helpful in leading the way toward our common goal of better agricultural living.

Employer Success and Industrial Relations

WHEN it first became apparent that "the public be damned" was not a good motto or frame of mind in which to conduct a business, American industry developed concepts of "public relations." At the outset this took the form of a special activity, more or less outside the main stream of business, in which some personable executive specialized in efforts to make friends for the firm. Later on it became evident that if the public reaction to thousands of individual contacts in transacting regular business were not, on the whole, favorable, there was no magic process whereby even an able public-relations man could correct a bad public impression. Today, most of our effort in the field of public relations is to develop the ability of employees to serve the public capably in day-to-day contacts.

A parallel may be suggested in connection with industrial relations. Once wages, hours, and working conditions are in order the situation will come down to the individual adjustment of employees to their jobs. One hardly needs to belabor the point that the man who is unsuccessful in his job is a source of acrimony and disharmony. His effect on the working group may be similar to that of one spoiled apple in a barrel. There is no sleight-of-hand performance which can better a relationship which is unsound from the outset. Improvement of selection techniques is the only apparent route to avoidance of those situations in which employers and employees must, on occasion, eat crow and like it.—*From "Tools of the Personnel Trade," by Guy W. Wadsworth, Jr., in "Mechanical Engineering" for January 1940.*

NEWS

Southern Section Meeting Program

A BALANCED program of four sessions, one featuring each of the four main subject matter interests of agricultural engineering, has been planned for the yearly meeting of the Southern Section of the American Society of Agricultural Engineers. This will be held February 7 to 9, at the Tutwiler Hotel, Birmingham, Ala., in conjunction with the annual meeting of the Association of Southern Agricultural Workers. Room 703 has been reserved for the Southern Section meeting.

Soil and water conservation will be the subject of the opening session, Wednesday morning, February 7. A. Carnes, chairman of the Section, will preside and introduce D. W. Cardwell, who is scheduled for a paper on "Runoff Studies from Small Watersheds"; J. R. Carreker, who is to present a "Preliminary Report of Runoff Studies of the Southern Piedmont Experiment Station"; and W. E. Hudson, whose subject will be "Engineering Aspects of Farm Planning."

K. J. T. Ekblaw, president of the American Society of Agricultural Engineers, will be a featured speaker on the farm structures program in the afternoon. His subject is "Engineering Factors in a Balanced Agriculture for the South." Other subjects and speakers of the same session will be "Farm Structures for a Balanced Southern Agriculture," by Ray Crow; "Equipment for Experimental Work in Curing Tobacco," by L. S. O'Bannon, University of Kentucky; "Methods of Teaching Farm Structures," by F. B. Lanham; and "Extension Methods in Farm Structures," by L. W. Dearing. J. W. Simons will preside at this session.

Rural electrification will occupy Thursday morning, February 8, with M. M. Johns, vice-chairman of the Section, presiding. F. M. Hunter is to handle the subject of "Electrification Through 4-H Club Boys." "What Land Grant Colleges in the South Offer for Student Training in Rural Electrification" is to be discussed by C. E. Seitz and R. H. Driftmier. L. L. Koontz has been named to summarize the "Organization and Activities of Electric Power Companies' Rural Service Departments." "The Rural Electrification Research Program of the Bureau (of Agricultural Chemistry and Engineering) as it applies to the South" will be reviewed by H. L. Garver.

At the close of this technical session the Section will hold a business meeting and election of officers. The afternoon has been left open for attendance at sessions of the Association of Southern Agricultural Workers and of other organizations meeting in conjunction with it.

C. V. Phagan will preside at the Friday morning session featuring farm power and machinery. The program includes papers on "The Mechanization of the Southern Cotton Plantation," by W. E. Meek; "An Outsider's View of the Farm Implement Business," by E. K. Rambo; "Legume Coverage Studies," by I. F. Reed; and "Cotton Ginning Improvements," by J. C. Ferguson.

A.S.A.E. members from outside the geographic limits of the Section are invited to attend. All who expect to be present are urged to make their hotel reservations early on account of the large number of visitors who will be in Birmingham at the time for the meeting of the Association of Southern Agricultural Workers.

Corvallis Next Pacific Coast Section Meeting Place

A TWO-DAY meeting of the Pacific Coast Section of the American Society of Agricultural Engineers has been scheduled for Friday and Saturday, February 16 and 17, at Corvallis, Ore.

Clyde Walker, vice chairman of the Section, is in charge of the program. This has not yet been completed, but he has indicated that he hopes to offer something on each branch of agricultural engineering, and to give particular emphasis to Pacific Coast interests in soil and water conservation and in rural electrification.

Other A.S.A.E. members located at Corvallis and key men in the group which will be host to the Section are D. L. DuBois, W. M. Hurst, M. R. Lewis, W. L. Powers, and F. E. Price.

Nominations for 1940-41 A.S.A.E. Officers

THE Nominating Committee of the American Society of Agricultural Engineers, consisting of R. B. Gray (chairman), Hobart Beresford, and I. D. Wood, have placed in nomination the following members of the Society as candidates for the various offices to be filled in the next annual election of officers:

For President

E. E. BRACKETT, head, agricultural engineering department, University of Nebraska.

For Vice-President

E. A. SILVER, research agricultural engineer, Ohio State University.

FRANK J. ZINK, research engineer, Allis-Chalmers Manufacturing Company.

For Councilor

M. R. LEWIS, senior agricultural engineer, U. S. Soil Conservation Service, and irrigation engineer, Oregon State College.

E. G. MCKIBBEN, associate professor of agricultural engineering, Iowa State College.

For Nominating Committee

ROY BAINER, agricultural engineering department, University of California.

C. J. HURD, agricultural engineering division, Tennessee Valley Authority.

F. R. JONES, agricultural engineering department, A. & M. College of Texas.

I. D. MAYER, agricultural engineering department, Purdue University.

A. W. TURNER, International Harvester Company.

The by-laws of the Society provide that 30 days shall be allowed for additional nominations by special nominating committees, at the expiration of which period (February 20), the Secretary of the Society will mail a secret ballot to all voting members.

A.S.A.E. Meetings Calendar

February 7-9, 1940—Southern Section, Tutwiler Hotel, Birmingham, Ala.

February 16-17, 1940—Pacific Coast Section, Corvallis, Ore.

June 17-20, 1940—Annual Meeting, State College, Pa.

August (last week, tentative)—Orono, Me.

December 2-6, 1940—Fall Meeting, Chicago, Ill.

Georgia State Section Fall Meeting

TWENTY-EIGHT members of the Georgia State Section of the American Society of Agricultural Engineers attended its fall meeting held in Athens October 14.

Beginning at 10:00 a.m. with J. C. Oglesbee, chairman, presiding, a program featuring talks in each of the four fields of Agricultural Engineering was presented.

Speaking on "News From the A.S.A.E. Front," R. H. Driftmier reported on the A.S.A.E. meeting at Saint Paul, Minnesota, the Southern Section A.S.A.E. meeting to be held in Birmingham, Alabama, and the fall A.S.A.E. meeting in Chicago, Illinois. He also stressed the need for continuous membership in the A.S.A.E., as well as taking an active part in committee work.

"Facts About Agricultural Engineering in Georgia" were related by W. N. Danner. He mentioned that A.S.A.E. members in Georgia in 1935 numbered approximately fifteen. In 1939 there were approximately sixty-five members. He told about the number of graduates the agricultural engineering department had been turning out, the placement of graduates in jobs, and the size of the classes in the department at the present time. He also introduced new members of the Section.

L. G. Duggar, speaking on "The Agricultural Engineering Side of the Farm Security Administration," gave its purpose, how the work is accomplished, the cooperation required with other government agencies, the various divisions of work, and the progress made in the past. The principal causes of failure for farm structures were enumerated and pictures, plans, and specifications of buildings completed were shown. Also, fundamental points concerning new construction and repair work were given, as well as average costs for new structures.

In reviewing the "Status of Rural Electrification in Georgia," G. I. Johnson traced the progress of Rural Electrification Administration from its inception to the present time, giving statistics concerning the amount of line building, the number of counties electrified, how Georgia ranks in rural electrification work, and the possibilities of future work.

"Recommendations of a Sub-Committee of the State Soil Conservation Committee" were given by J. R. Carreker. Mr. Carreker, after mentioning the fact that his committee needed the approval of the state committee before the recommendations could be published, *(Continued on page 31)*

An Appreciation of Dan Scoates

By Dr. T. F. Mayo

THE passing of Daniels (Dan) Scoates, announced in AGRICULTURAL ENGINEERING for December, was a heavy loss not only to agricultural engineering in particular but to technical education in general. From 1911, when he became head of the department of agricultural engineering at Mississippi State College, to 1938, when he was attacked by his last illness, Mr. Scoates was one of the major figures in our profession. He deeply influenced its development during its vital formative years. In 1910, when he graduated from Iowa State College and began his teaching career at Montana State College, the American Society of Agricultural Engineers was just three years old. AGRICULTURAL ENGINEERING was not to begin publication for ten more years. It was in a comparatively new and unformed profession that he was to spend the twenty-nine years of his professional life.

In the course of that professional life, Mr. Scoates has developed pioneer departments of agricultural engineering in the technical colleges of two states. He has written two full-length books: "Land Drainage and Reclamation" (1928, with Q. C. Ayres), and "The Game of Planning a Home" (1933).

As a leader in a young profession, Mr. Scoates has also played a prominent part in establishing affiliations between the teaching of agricultural engineering and other divisions of the field. As consulting editor of the McGraw-Hill Book Company, he supervised their important series of publications in agricultural engineering. As agricultural engineering editor of *Southern Ruralist*, he helped to introduce and clarify the subject to a wide circle of magazine readers. As president of the American Society of Agricultural Engineers (1917), he officially led the profession for a year. As secretary for fifteen years of the Texas Hardware and Implement Association, he performed the vital service of promoting understanding and cooperation between the educational and the commercial sectors of the field. Finally, as head of project planning in the Texas division of the Rural Resettlement Administration, he served as an important link between education and social planning in agricultural engineering.

DANIELS SCOATES
(1882 - 1939)

Mr. Scoates has been not only an active and efficient professional man, but a very human and likable one as well. His book, "The Game of Planning a Home", bears evidence on every page, in style as well as in content, of his warm interest in the betterment of country life and his practical energy in contributing to it. Its opening sentence begins: "The present prospective house or home builder (and I like to think of him as a home builder) . . . ." Its last sentence reads: "The author hopes that it (the book) will in a small way help the many present and prospective house and home builders to have more likable dwellings."

Mr. Scoates' campus influence, on committees and otherwise, has been exerted to encourage cultural breadth in student life. A technical man himself, he was yet broadly human enough to realize that man does not live by technique and salary alone. He spent, moreover, many hours and much deep thought in personal student guidance.

If, then, the comparatively new field of agricultural engineering is already firmly established in our technical colleges, solidly knit together in its educational, commercial, and social aspects, and cultivated in a broadly humanistic spirit, these advantages are due to just such men as Daniel Scoates. In sadly and appreciatively bidding him hail and farewell after his twenty-nine years of distinguished service, his personal friends and his professional colleagues wish to pay due honor to his memory and to the good things that he leaves to his profession and ours.

* * * * *

EDITOR'S NOTE: To the foregoing excellent tribute to Dan Scoates, we add one by his long-time friend and ranking associate in the department of agricultural engineering at the A. and M. College of Texas—Fred R. Jones—contained in a letter addressed to Prof. Scoates' former students, as follows:

"Texas and the nation has lost one of its most outstanding agricultural engineers. The fact that our agricultural engineering department during the past twenty years has grown from an almost unknown department into one which ranks with the best in the country, is perhaps the greatest tribute to his ability, energy, and character. It is most unfortunate that he should have to drop out without being able to enjoy the satisfaction and inspiration of such service and achievement. The agricultural engineering building and facilities which we now enjoy at Texas A. & M. are the finest in the United States, and will stand as a monument to his many attributes. We, his associates and co-workers here at A. & M., shall miss his leadership, but the memory of his enthusiasm and untiring energy, we know, will continue to furnish us the necessary inspiration to carry on in the years to come."

Agricultural Engineering Student Honored

WILLIE LEE ULICH

ONE of the freshman class in agricultural engineering at A. and M. College of Texas is Willie Lee Ulich, recently accorded national honors as winner of the national 4-H Club Leadership Contest for 1939. This gave him a $300 scholarship and possession for one year of the Moses trophy for leadership. Following this award a statewide 4-H Club achievement dinner was held in his honor, December 14, at the A. and M. College of Texas.

Mr. Ulich is 19, married, and working his way through college. In six years of membership he has served as president of the Lyons 4-H Club, and of the Burleson County 4-H Club, and as a member of county cotton classing, plant propagation, and dairy demonstration teams which placed high in state contests. He was also one of the organizers and president for three years of the Burleson County Registered Hog Association.

Georgia State Section Fall Meeting

(Continued from page 30)

outlined in a few words the ideas and thoughts behind the various recommendations as well as the recommendations themselves. He mentioned farm water disposal plans, terrace outlets, terraces, pasture ridging, farm road location, fencing, subsurface drainage and stock ponds.

"Impact Characteristics of Rubber Transport Wheels" were reviewed by R. L. Green. Mr. Green gave the high points of his year's work at Iowa State College. He mentioned impact, wear, and soil movement under steel-wheel and rubber-tire conditions, giving a comparative analysis of the two.

C. W. Chapman then invited the group to plan a deep-sea fishing trip off the lower coast of Georgia during the spring, as a function of the spring meeting to be held in 1940.

Personals

B. A. Jennings explains "Binder Adjustments" in Cornell Extension Bulletin No. 417.

Archie A. Stone has written a booklet entitled "Tractors for Gardens and Small Farms," which is published by the New York State Institute of Applied Agriculture at Farmingdale, L. I.

E. T. Swink is author of Virginia Agricultural Extension Bulletin No. 147 on "Electric Equipment for the Bactericidal Treatment of Dairy Utensils."

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the December issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

G. Detjen, president, Detjen Corp., 303 West 42nd St., New York, N. Y.

R. Jas. Groves, student, Ontario Agricultural College, Guelph, Ont., Canada.

R. W. Kuykendall, sales representative, B. F. Goodrich Co. (Mail) Box 794, Enid, Okla.

Fred M. Potgieter, sales engineer, Mechanics Universal Joint Division, Borg-Warner Corp. (Mail) Rockford, Ill.

Hugh C. Smith, technician, The Sisalkraft Co., 205 W. Wacker Drive, Chicago, Ill.

Jorge L. Sola, representative, Argentine National Cotton Board, Argentine Embassy, 1816 Corcoran St., N.W., Washington, D. C.

John P. Spielman, junior engineer trainee, rural electrification administration, U. S. Department of Agriculture, Washington, D. C. (Mail) 1426 21st St.

Donald C. Wiggins, agricultural engineer, American Steel & Wire Co., Carnegie-Illinois Steel Corp. (Mail) 1890 E. 105th St., Cleveland, Ohio.

John W. Wolfe, graduate assistant, department of agricultural engineering, University of Idaho, Moscow, Idaho. (Mail) 217 N. Almon.

TRANSFER OF GRADE

W. H. Mikell, Jr., assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) Box 236, Chester, S. C. (Junior Member to Associate)

Student Branch News

OHIO

THE first meeting of the Ohio Student Branch of the American Society of Agricultural Engineers for the 1939-40 school year was held October 12, 1939.

President Robert Hartsock announced that the University 4-H Club had invited the Branch to be their guests on October 25. Their invitation was accepted. A discussion was held as to when the Branch should meet, and it was decided that the meetings would be held every two weeks beginning on October 19.

Cecil Robinson was placed in charge of "Open House" which was held on October 19, and plans were made for a successful membership drive.

In view of the fact that the Branch wants to help each member further his own interests, the president called for suggestions of activities for the present year and the following ideas were presented:

Social—To have mixed group and dinner meetings.

Program—To have meetings which are seminar in type with both the technical and practical phases of engineering to be discussed; to induce more student participation; to have talks by men working on agricultural engineering problems.

Athletics—To enter teams in intramural competition.

General—To encourage musical talent; to endeavor to define agricultural engineering: to take the lead in getting acquainted with other engineering student branches on the campus; to develop our reading room into a club room.

Paul Yoder was elected to the seat on the Engineers' Council which had been left vacant by Ralph Patterson, who is not in school this year.

On October 19, the Branch held one of its most successful "Open House" meetings. Entertainment and refreshments were provided, and all of the present and prospective members reported a pleasant evening.

The next meeting of the Branch was held on November 2, at which time the group was informed that bowling had started and that the Branch was entered in intramural basketball. Several of the alumni were present at this meeting, including Royal, Fultz, Patterson, and Rofkar. All of these men gave short talks on their positions in industry, so as to give the student members some idea of what to expect upon graduation. Several of the students gave interesting reports on the Annual Meeting of A.S.A.E., after which Mr. Rofkar discussed the transition of the college graduate into industry.

At the meeting of November 27, Mr. Yoder, as representative to the Engineers' Council, announced that the Branch was eligible to participate in the engineers' athletic league, and that plans for the engineers' dance were practically completed. It was announced by President Hartsock that the agricultural function for the winter quarter would be a carnival-dance. The Branch is laying plans for its "Farmers' Week" lunch stand with hopes that it will be as successful as it was last year.

All of the members were proud to hear that President Hartsock had been pledged to Tau Beta Phi, national engineering honorary fraternity.—*David E. Parr, chairman of publications.*

TENNESSEE

FIRST place was given to the float, sponsored by the University of Tennessee Student Branch, in the Annual Barnwarmin' Parade, but due to its ineligibility, it did not receive the cup. Only the Greeks were competing for the prize. The A.S.A.E. float was Tennessee riding the tide, since the parade took place just before the Tennessee-Alabama football game.

Membership in the Tennessee Branch is growing steadily. Outstanding programs which the club has had this year were talks by G. E. Martin and John A. Schaller. Mr. Martin, agricultural engineering extension

TENNESSEE RIDING THE TIDE

worker in Tennessee, gave a talk on the future of agricultural engineers which was encouraging to all the members. Mr. Schaller, assistant agricultural engineer of the TVA, showed slides, and gave explanations on barn-drying of hay. Two of our members gave reports on the Industry Seminar, which they attended in September.

Erection of a new agricultural engineering building has begun, and there will be a room in it for the Branch.—*Marcellus Harris, publicity committee.*

SOUTH CAROLINA

THE South Carolina Branch of The A.S.A.E., which was introduced to Clemson College in 1932, had the following written into the Constitution:

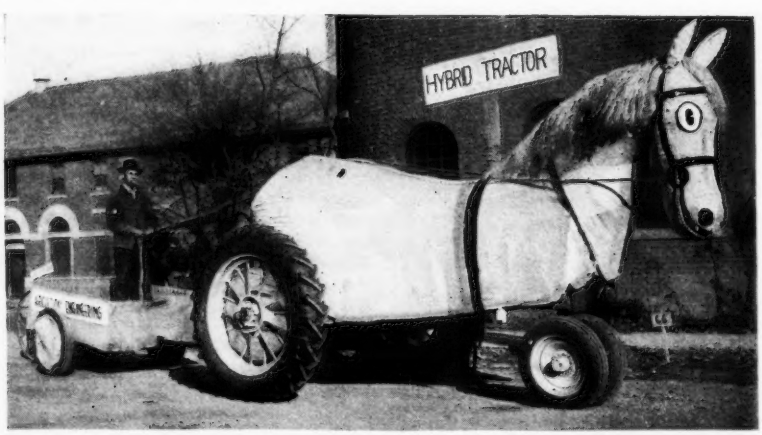
"1 Membership in the Branch shall consist of students who are majoring in agricultural engineering at Clemson.

"2 Each new member must have acquired a grade-point ratio of three or above on all scholastic work since entering Clemson."

A grade-point ratio of three represents work slightly above average. We believe that this requirement stimulates more interest in becoming a member of the Branch, since it represents achievement. The requirements are lowered slightly for seniors who have not been taken in previously. This arrangement has proved satisfactory as it gives the underclassmen a goal to work for, yet it allows every man to become a member of the Branch while in college.—*R. L. Hearon, secretary.*

IOWA

"HOLIDAY GREETINGS" were extended by the Iowa Student Branch in a newsy 20-page booklet on recent activities and future plans of the Branch and faculty.



Strange things happen when Agricultural Engineering students from South Dakota State College prepare for the Hobo Day parade, an annual Home-coming event. First prize was the reward for this ingenuity and cooperation of the Student Branch members

REPORT ON FUEL SYSTEM

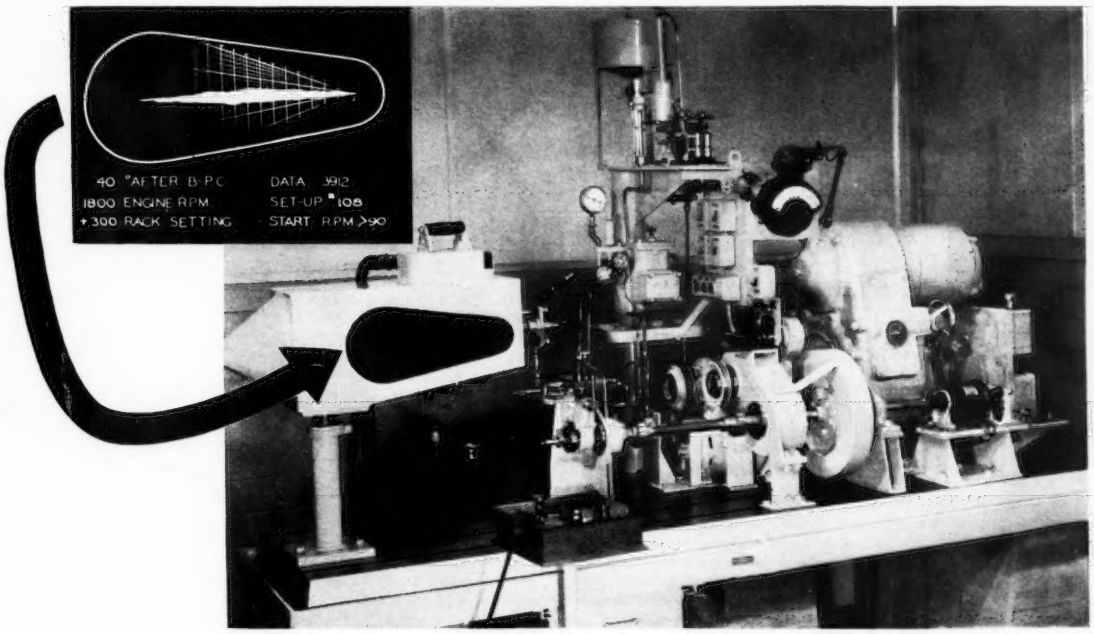
After 3,500 working hours! *The facts . . .*

Owner: Ray Fosberg, Oneida County, Idaho — **Type of Work: Grain farming**

Tractor: "Caterpillar" Diesel D4 — **Total Repair Expense: None**

Hours Worked: 3,500 (to June 14, 1939) — **Service Expense: $6.50**

Diesel Fuel System Condition: Excellent!



RESEARCH REASONS BEHIND THE RECORDS!

With the advantage of pioneering Diesel Tractor manufacture, instead of being forced in by competition, "Caterpillar" had a background of vital research experience—*second to none in the world*—before selling its first Diesel Tractor!

For this company found it necessary and desirable to know what characteristics a heavy-duty Diesel Tractor's fuel system should possess—for performance, for manufacture and for long service-life.

Such research equipment as the testing machine shown here is behind the field performance—and future progress—of "Caterpillar" Diesels. It is a high-speed Stroborama, synchronized with the drive of the "Caterpillar" laboratory fuel system test bench—and like many another specialized "Caterpillar" research machine, it was designed and built by this company's engineers!

With uncanny precision the Stroborama can determine the time of injection-beginning, within one-eighth crankshaft degree for any engine speed, and with injection quantities to correspond with any engine load. And this machine helps guide the engineers to injector design that produces the proper spray contour and penetration for clean combustion.

Unsatisfied with thousands of records as good as, or better than, Ray Fosberg's, "Caterpillar" pursues its scientific search for Diesel engine perfection!

CATERPILLAR

TRACTOR CO. • PEORIA, ILLINOIS

DIESEL ENGINES **TRACK-TYPE TRACTORS** **TERRACERS**

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers thereof, whose names and addresses may be obtained on request to AGRICULTURAL ENGINEERING, St. Joseph, Michigan

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE NEW HAVEN STATION. Connecticut [New Haven] Sta. Bul. 421 (1939), pp. 34, 35. The report notes the success of various treatments of native woods, used to replace chestnut, with creosote, zinc chloride, etc. It is noted that wind-felled timber left by the hurricane can be so utilized.

AGRICULTURAL ENGINEERING INVESTIGATIONS AT THE MASSACHUSETTS STATION. Massachusetts Sta. Bul. 355 (1939), pp. 52, 53. This work included a cranberry storage investigation, by C. I. Gunness, H. J. Franklin, and C. R. Fellers; and a study of frost protection on cranberry bogs and construction of tobacco seed cleaner, both by Gunness.

DEEP WELL IRRIGATION IN THE OKLAHOMA PANHANDLE, *W. Langham and W. N. McMillen*. [Oklahoma] Panhandle Sta., Panhandle Bul. 64 (1939), pp. 22, figs. 6. The water supply in the water-bearing strata is at present large but is the accumulation of years of seepage and has no other important sources. However, "though the depletion of this water supply is possible, it seems unlikely that irrigation will become extensive enough under the present conditions of high power rates, high pumping lift, and cheap crops to make the condition very probable." The quality is found to be good, but the mean depth of water-bearing strata in Cimarron County was somewhat more than 160 ft as against an estimate of 100 ft as the maximum economically practicable pumping lift. Cost is found to be the limiting factor. In an example given, "when the total annual pumpage was 273 acre-feet, fixed costs accounted for 41 per cent of the total cost of an acre-foot of water, including the labor. Had this well been used to pump only 100 acre-feet, the total cost per acre-foot would have been $9.53, of which approximately 66 per cent would have been fixed charges. It is obvious that this item alone would make the pumping of water unprofitable regardless of the power rate. Though the item of fixed costs increases with the pumping lift, if maximum use of the plant is obtained, this item may not make cost of pumping prohibitive for pumping lifts well over 100 ft. Provided that operation costs can be minimized by an abnormally low rate of power, deep well irrigation may have some possibilities. Especially is this true in those favored areas along the creeks and rivers where the pumping lift may not be excessive. In these areas the development of natural gas resources affording a cheap source of power may even justify irrigation expansion, though it is obvious that dry-land farming must remain the basic agriculture in the entire region as a whole."

The relation of soil conditions to practicability of well irrigation, the status of four High Plains irrigation projects, general cost analyses, description of the well and pumping plant of the station, together with the cost of the well and equipment and the costs of operation, and cropping and water-handling notes are among the contents of the bulletin.

LUMBER REQUIREMENTS FOR NONFARM RESIDENTIAL CONSTRUCTION, *F. J. Hallauer*. U. S. Dept. Agr., Misc. Pub. 347 (1939), pp. V+39, figs. 18. The author found evidence of a cyclical period of about 18 yr in the construction of nonfarm housing units and suggests a pattern for the cycle ending about 1950.

There has been a noticeable trend to brick and stucco over frame, but lumber exterior face makes up only some 10 per cent of the total lumber in an all-wood house, and a partial substitution of other materials has not greatly reduced the lumber per unit. An analysis arrives at a prospective average annual requirement of 6.4 billion board feet of lumber for new residential construction and 1.4 billion board feet for repairs per annum. These estimates are based on the volume for a decade and cannot be applied to any one year. "An estimate year by year can be arrived at by applying the lumber per unit to the suggested construction cycle."

EROSION AND RELATED LAND USE CONDITIONS ON THE SCANTIC RIVER WATERSHED, CONNECTICUT-MASSACHUSETTS, *P. H. Montgomery*. U. S. Dept. Agr., Soil Conserv. Serv., 1939, pp. 27, pls. 21, fig. 1. The Scantic River rises about 12 mi southeast of Springfield, Mass., and flows southwest to the Connecticut River, about 7 mi north of Hartford, Conn. The watershed comprises about 71,129 acres.

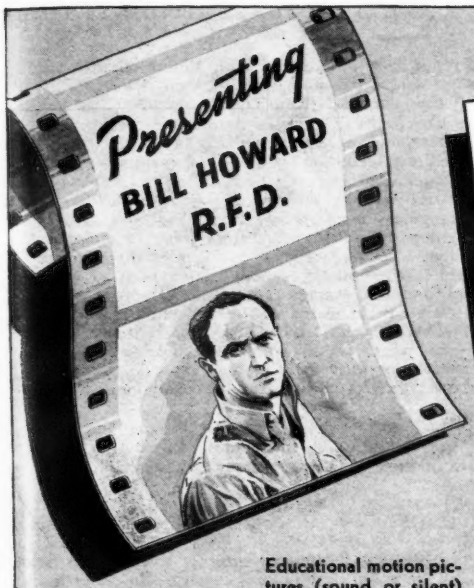
Of the entire watershed, 8.2 per cent showed no apparent erosion, 66.7 showed slight erosion, 20.6 moderate, 1 severe, and 0.1 per cent very severe. The corresponding figures for cropland are 0.1, 65, 31.2, 0.7, and 0 per cent. Like data were obtained from idle land, pasture, and woodland. The usual control measures are recommended where needed.

FLOW OF WATER IN IRRIGATION AND SIMILAR CANALS, *F. C. Scobey*. U. S. Dept. Agr., Tech. Bul. 652 (1939), pp. 79, pls. 24, figs. 5. This bulletin presents a detailed analysis of the factors involved in the design and performance of canals supplying water for irrigation or other uses. Particular attention is given to the choice to be made among various empirical formulas for determining the value of n, the coefficient of hydraulic roughness. In addition to evaluating n under conditions such that the design will be satisfactory at the critical part of the season, the author finds it necessary to consider prevailing wind direction and notes other important design factors as follows:

"In the design of earth channels having a trapezoidal form when constructed, the computations should be based on the expectation that the canal will take an elliptical form within a short time and thereafter maintain this shape unless altered artificially. Capacity of old rough concrete canals can be materially increased at a fraction of the capital charge for the original construction. Shot concrete should be surface-treated [by striking with a rectangular blade] to secure high capacity. If capacity is sufficient . . . water tightness is better assured without surface treatment, as this includes a tendency toward more porous concrete. Initial high capacity due to smooth surfaces is not a permanent feature where muddy waters predominate. Such water increases the capacity of a very rough channel and decreases the capacity of a very smooth one. Determinations of the values of n in experimental research work should not be conducted on the basis of the surface slope. The energy slope is the effective quantity and agrees with the surface slope only for uniform flow, and uniform flow cannot be assumed to be present. Generally it is not. If cross-sectional areas are developed at the ends of a test reach, no matter how uniform the flow looks or should be, it is generally found that these areas are unlike. Hence the velocities are unlike and have different investments of velocity head in their total energy contents."

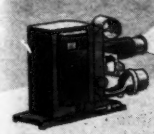
AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE WYOMING STATION, Wyoming Sta. Rpt. 1938, p. 30. It is noted that four fields have been fallowed with the Peacock damming lister, the eccentric one-way plow, the common stubble plow with the moldboard removed, and the duckfoot cultivator, respectively, with no resulting runoff or soil blowing on any of these fields.

HUMAN AND PHYSICAL RESOURCES OF TENNESSEE.—XVI. ELECTRICAL RESOURCES AND DEVELOPMENT, *C. E. Allred, S. W. Atkins, and W. E. Hendrix*. Tenn. Agr. Col., Agr. Econ. and Rural Sociol. Dept. Monog. 64 (1937), pp. [1]+IV+264–278, figs. 7. It is stated that only New York State, Oregon, and Washington have more potential water power per square mile than does Tennessee. The last-named state ranks tenth, however, in developed hydroelectric power. The rapid development since construction of the first modern hydroelectric plant in the state in 1909 is outlined. The number of plants and of electric power companies has decreased more than 50 per cent since 1924. Electric transmission lines were found to reach nearly all counties of Tennessee. Since 1920 Tennessee has averaged about twenty-sixth in the United States and about fifth in the Southeast in production of electricity. The annual production since 1929 has averaged slightly over one billion kilowatt hours. In 1936, 75 per cent of the electricity was produced by water power and 25 per cent by fuels. The importance of fuels in producing electric power has declined considerably since 1933. The largest use of fuels is in late summer and early fall, when stream flow is usually low. The largest users are wholesale commercial customers, principally large industrial companies. Farm power ranks lowest. *(Continued on page 36)*



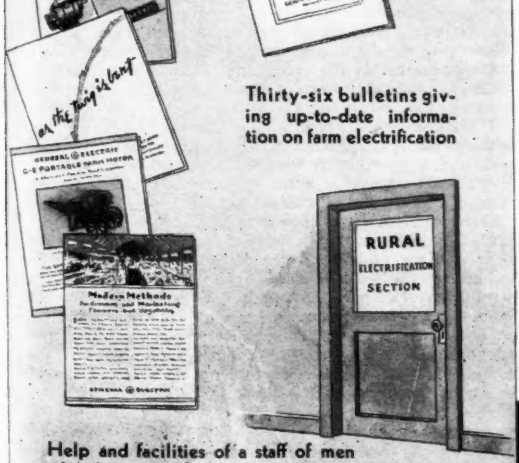
Educational motion pictures (sound or silent)

Slide films (sound or silent) on specific farm electrification problems



ELECTRICITY *and* PLANT GROWTH

Thirty-six bulletins giving up-to-date information on farm electrification



Help and facilities of a staff of men who have devoted over 15 years to farm electrification problems

Brief notes to a busy agricultural leader

HERE'S HELP

On a Tough Problem

THOUSANDS of farm families are considering using electricity for the first time. They have questions to ask. What about cost? What buildings should be wired first? How about electrical help in the dairy—in the poultry house? These and a hundred others. Naturally, they turn to you for answers. And where do *you* turn?

That, of course, is up to you. But may we offer the free services of our Rural Electrification Section to help you?

Exactly How Can We Help

We have a number of publications in which you'll find the answers to 75 per cent of the questions they'll ask. On the other 25 per cent we'll be glad to give you personal service. And here's another thought: General Electric's movies and slide films on farm subjects will answer a host of questions even before they arise.

The publications, movies, and slide films are ready, waiting to help lift a big job from your shoulders. As step number one, we'd suggest that you drop us a line requesting these booklets. You can easily find in them the solutions of most of your farm families' electrification problems. After that, call on us whenever the need arises. We'd really like to help. Address General Electric, Rural Electrification Section, Schenectady, N. Y.

GENERAL ELECTRIC

98-24

Agricultural Engineering Digest

(Continued from page 34)

AFFINITY OF HYDROPHILIC AGGREGATE FOR ASPHALTIC BITUMEN, *H. F. Winterkorn.* (Univ. Mo.) Indus. and Engin. Chem., 30 (1938), No. 12, pp. 1362-1368, figs. 4. By means of a wash test following various pretreatments, the author showed that the stripping resistance of bitumen-coated aggregate depends upon the properties of the bitumen, the surface properties of the mineral, and the time and condition of contact between bitumen and mineral surface. Soaking followed by the wash test was found a more time-consuming but also a more discriminating procedure. The effect of washing the aggregate with hydrochloric acid and aqua regia before coating depends upon the character of the mineral surface and that of the bitumen. Washing with aqua regia tended to improve the adhesiveness more than washing with hydrochloric acid. Samples taken from a bituminous soil stabilization project, in some sections of which rein-forming primers were used, were tested in the laboratory with the result that specimens containing anilin-furfural, high-temperature tar-furfural, and low-temperature tar-furfural admixtures showed better resistance to water than samples which did not contain these materials.

"The evidence appears to show that furfural and its resinous derivatives might be destined to fill an important place in bituminous road construction. While these materials cannot be expected to cure all the evils for which lack of adhesiveness is often blamed, they deserve careful consideration in cases where stripping is encountered."

THE RELATIONSHIP OF STREAM FLOW TO PRECIPITATION ON THE SALT RIVER WATERSHED ABOVE ROOSEVELT DAM, *C. K. Cooperrider and G. G. Sykes.* Arizona Sta. Tech. Bul. 76 (1938), pp. [3]+69, figs. 10. A foreword by the director of the station notes that "this bulletin is published by the agricultural experiment station of the University of Arizona in cooperation with the Southwestern Forest and Range Experiment Station in order that the important information it contains may be made available at once to the people of Arizona to whom such facts are vital in their management of land resources." Its contents are, in part, introduction, importance of watered areas, need for knowledge about factors that affect water yield, watershed and precipitation characteristics affect water yield, records and analyses, close relationship between precipitation and stream flow on the upper part of the watershed, further tests of relationships of fall and flow, long-time trends, why summer precipitation contributes so little to stream flow, precipitation-stream flow relationships in the lower part of southwestern watersheds, and application of findings in watershed management.

AGRICULTURAL ENGINEERING INVESTIGATIONS BY THE NEBRASKA STATION, Nebraska Sta. Rpt. [1938], pp. 5-7. This report contains brief notes on tractor testing, use of electric power on Nebraska farms, methods of cooling milk on the farm and their effect on quality, performance characteristics of rubber tires on tractors, mechanical equipment needed in the eradication of bindweed, adaptability of electric hotbeds to farm use, adaptation of insulated electric brooders in uninsulated poultry houses, and methods and equipment for curing and preserving perishable farm products under controlled temperature and humidity adaptable to use on the farm.

DRYING SEED COTTON, *F. L. Gerdes, W. J. Martin, and C. A. Bennett.* U. S. Dept. Agr. Leaflet 181 (1939), pp. 8, figs. 3. A 17-floor drier at a temperature of 150 F removed from about 1 lb per 100 lb of seed cotton with less than 12 per cent moisture to 3 lb from cotton having 16 per cent or more when the cotton was exposed 15 sec. The percentage removed from each of these cottons at temperatures up to 250 F was only slightly greater than at 150 F. This result was attributed to the relatively short exposure in the drier (15 sec) and the fact that the relative humidity of the air heated to the higher temperatures is not appreciably lower than that at 150 F. The moisture removed from lint per 100 lb by drying for 15 sec at 150 F ranged from an average of 1.5 lb for seed cottons below 12 per cent in moisture to an average of 4 lb for those having 16 per cent or more. It increased slightly with higher drying temperatures. Actual differences in the weight of bales due to drying are not permanent. The results of a storage test show that a bale of undried (damp) cotton rapidly lost weight; that a dried bale gained slightly; and that, at the end of 10 weeks, the bales differed in weight by only 4 lb as compared with 16 lb at the beginning of the storage period. Fiber was not weakened by drying at 200 F, but there was a slight weakening of the fibers when the material was dried twice at 250 F. Staple length, on an average, was preserved at 150 F, but, in general, higher drying temperatures resulted in ginned lint with slightly shorter staple length. It was found better to pass wet cotton twice through a drier at 150 F than once at a temperature above 200 F.

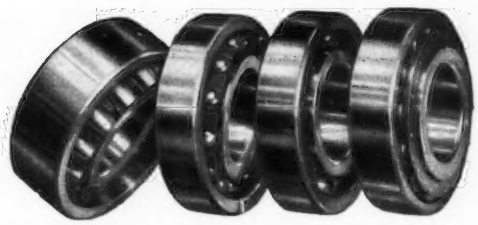
Average improvements in grade of cotton (the combined influence of generally smoother preparation and occasionally brighter color and reduced leaf) resulting from artificial drying were greater for the cotton 1⅛ in and longer than for the shorter staples. Drying at a temperature of 150 F with the 17-floor drier showed benefits in grade ranging on an average from about one grade for either length group having 16 per cent or more of moisture to about one-third of a grade for the longer cottons having from 8 to 11.9 per cent and the shorter cottons having from 12 to 15.9 per cent of moisture. The average gain in bale value was from 70 cents for short staple to $2.50 for long staple cotton as against an operating cost of from 5 to 30 cents per bale for drying. It was further found that drying usually eliminates chokages and breakdown and permits some increase in ginning capacity. Inexpensive cleaner-driers economically practical for the small gin have been devised.

As sources of heat, steam, engine-cooling water and engine exhaust, and furnace heating are mentioned, and the possibilities of combinations of these sources are briefly indicated.

FACTORS WHICH INFLUENCE THE DURABILITY OF CONCRETE STAVE SILOS, *D. G. Miller.* (Univ. Minn. and U.S.D.A.) Jour. Amer. Concrete Inst., 9 (1938), No. 4, pp. 381-397, figs. 15. The author examined about 200 concrete silos in several states and obtained test data on 1,350 experimental concrete silo staves made at 9 commercial plants to determine the effect of mix or number of staves per bag, tamping (the number of tamps per stave), water : cement ratio, and aggregate grading. It is shown by results of permeability tests that the transverse strength and density of silo staves are closely related, and the inference is drawn that the greatest durability may reasonably be expected of those staves having transverse strengths upward from 140 lb per inch of width when tested by applying the load midway between supports 24 in apart. It is shown in the report that the 10-min absorption of a stave, following drying to constant weight at a temperature of 240 F, is a direct measure of permeability. For strengths above 140 lb per inch of width the quantity of water absorbed after 10 min is between 1 and 2 per cent and is fairly constant. The 10-min absorption therefore provides a simple test for permeability of dry-tamped staves, and thus makes it reasonably easy to correlate strength and density of staves as a basis for studies of durability under exposure conditions found in silos.

STUDIES ON RARITAN RIVER POLLUTION, II, 1937-38, *W. Rudolfs.* New Jersey Stas. Bul. 659 (1939), pp. 22, figs. 7. In a survey of Raritan River and its principal tributaries, May 1937 to March 1938, it was shown that the natural waters of the Raritan do not change materially in chemical composition, are fairly clear, are the least mineralized in northern New Jersey, and have a low bacterial content. They are, therefore, admirably suited for industrial purposes, are fit for recreational use, and are an excellent source of potable supplies. During a 10-yr period bacterial pollution has decreased and chemical pollution has increased, the last-named pollution appearing to come mainly from between the towns of Somerville and Bound Brook. The discharge of chemical wastes appeared to interfere with the self-purification and oxidation power of the stream, to be detrimental to fish life, and to prevent the fullest recreational use of the river. It is further noted that "discoloration and annoyance in respect to sailing and rowing craft will continue until the industrial wastes responsible are adequately treated. The bacteriological results show that the river is still unfit for swimming, but it is expected that upon completion of all sewage plants under construction the health hazard will be greatly reduced because of removal of polluting substances and chlorination of effluents discharged." The sludge and other oxygen-consuming substances removed by the treatment in sewage plants were found equivalent to 8,750 lb of oxygen or to the addition of from 90 to 120 million gallons of clean water daily. It was indicated that intestinal bacteria will be reduced during the summer months (May-October) by 99.9 per cent or more, but "until pollution from industrial sources has been alleviated, the general improvement of the river will be less than could be expected from the investment in sewage treatment plants by the various communities. A summary of the newly constructed sewage plants is presented, and the probable purification effects are indicated.

AGRICULTURAL ENGINEERING WORK AT THE KENTUCKY STATION, Kentucky Sta. Rpt. 1938, pt. 1, p. 53. Observation of the formation of temperature and humidity zones in tobacco barns indicated that it will probably be necessary to use forced air circulation in some form in order to maintain optimum conditions in all parts of such barns. *(Continued on page 38)*



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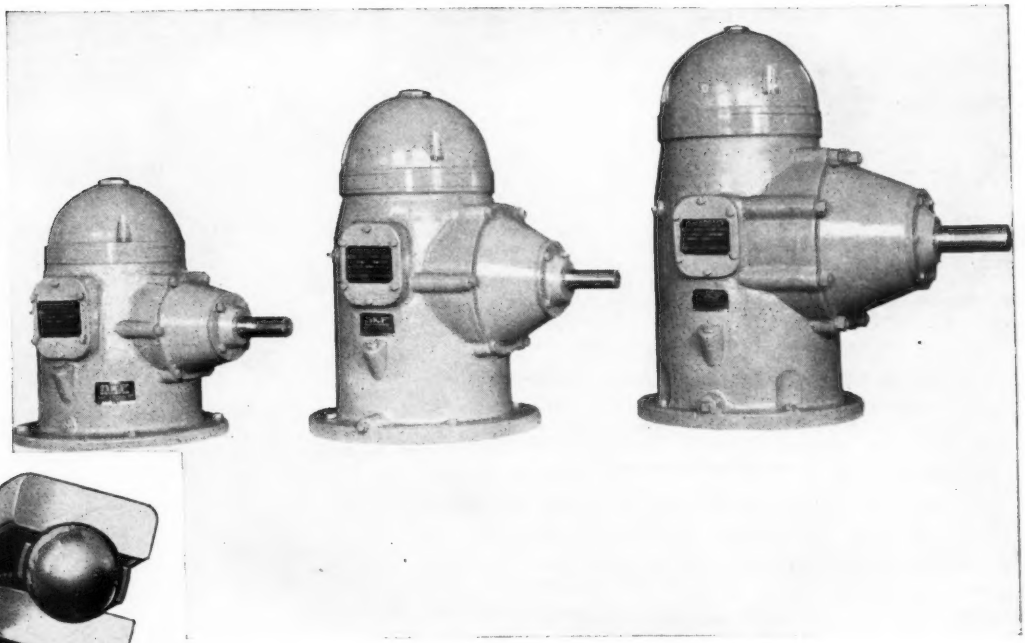

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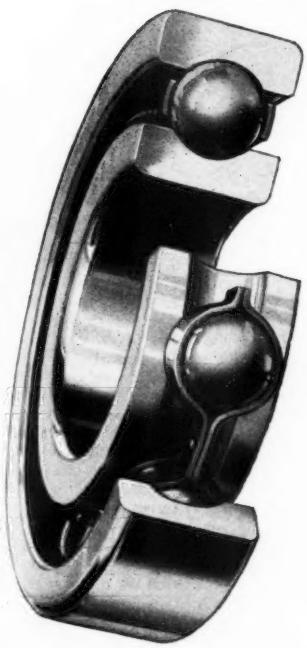

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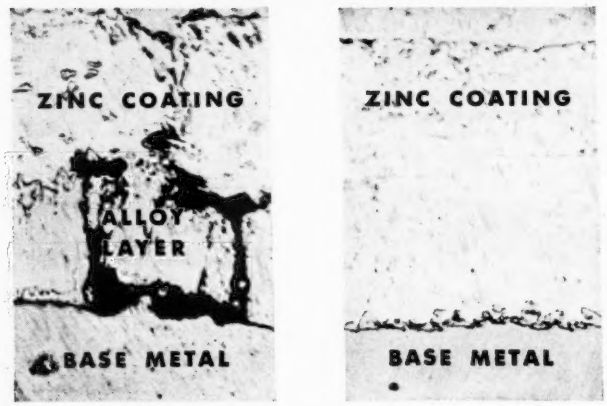

Photomicrographs of cross sections of ordinary galvanized metal and of ARMCO ZINCGRIP magnified 1000X . . . after both sheets had been stretched 15%.

• **Ordinary galvanizing shown at left.** Note the cracks in the entire coating, especially along the surface of the base metal. The coating has broken away entirely.

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Agricultural Engineering Digest

(Continued from page 36)

FARM DRAINAGE: ITS MAINTENANCE AND CONSTRUCTION, *E. W. Lehmann and T. A. Pitzen.* Illinois Sta. Cir. 493 (1939), pp. 40, figs. 31. For the maintenance of best farming conditions, more than one-third of the farm lands in Illinois must be artificially drained, and the total of public and private drainage structure investment in the state amounts to about $150,000,000. The authors warn against installation of expensive drainage systems without provision for their regular and thorough repair and efficiency maintenance.

The main topics taken up in this circular cover maintenance of open channels, maintaining the tile system, planning a tile system, constructing outlet for tile system, constructing the tile lines, surface inlets and sand traps, and file maps and records. Diagrams, photographs, dimensioned working drawings of various structures, and numerical data of value in the design of drainage systems are included.

TERRACE OUTLETS AND FARM DRAINAGEWAYS, *C. L. Hamilton.* U. S. Dept. Agr., Farmers' Bul. 1814 (1939), pp. II+46, figs. 27. This bulletin is designed as a practical guide for the construction and maintenance of terrace outlets and the protection, improvement, and maintenance of drainageways serving as channels of surface drainage for the upper parts of watersheds or in unit drainage basins. It is noted that "the scope of this material is limited to surface runoff disposal measures required in upland or rolling terrain where slopes are steep enough to cause channel erosion. It does not cover surface drainage or underdrainage of flatlands where natural drainage is inadequate."

TILE DRAINAGE TRIAL AT THE INDIANA STATION, *A. T. Wiancko, G. P. Walker, and C. Robbins.* Indiana Sta. Cir. 244 (1939), pp. 5, 6. A tile drainage experiment designed to determine the value of tile drainage and the most practical size, depth, and spacing of tile lines on the Clermont silt loam of the Jennings County Experiment Field is very briefly noted.

AGRICULTURAL ENGINEERING NOTES. Miss. Farm Res. [Mississippi Sta.], 1 (1938), Nos. 1, p. 7, fig. 1; 3, p. 2, fig. 1; 2 (1938), Nos. 1, p. 2; 2, p. 7, fig. 1; 3, p. 5; 5, p. 8; 6, p. 6; 7, p. 2. The listed numbers of this periodical contain brief popular articles as follows: Middle Buster Used to Harvest Sweets, Mower-Crusher Perfected by Station Cuts Hay Curing Time in Half, and Mechanical Power Displacing Human Labor to Ever-Increasing Extent, all by T. N. Jones; Flue-Heated Hotbeds for Earlier Plants, by W. S. Anderson; Modern Planting Equipment Suitable to Work of Diversified Farms, by T. N. Jones; Small-Area Irrigation is Practicable and Profitable on Many Mississippi Farms, by L. R. Furnish; and Mower Adjustment and Slope Percentage a Vital Factor in Erosion Control, both by T. N. Jones.

Literature Received

SOIL CONSERVATION, by Hugh Hammond Bennett. Cloth bound, 993 pages, 6x9 in, 358 illustrations, 47 tables, 17 maps, indexed. This is the most nearly complete treatment of the subject that we have seen in any one book. It is presented in two parts covering, respectively, soil erosion and soil conservation. Chapters on soil erosion cover the problem in the United States, erosion and civilization, results of erosion, processes and types of erosion, rates of erosion and runoff, relation of physical and chemical properties of soils to the erosion problem, climate and soil erosion, infiltration in relation to runoff, the erosion process, and the utilization of rainfall, relation of erosion to crop yields, relation of erosion to vegetative changes, sedimentation, mass movement an important process of soil wastage, geology and soil erosion, and relation of entomology to erosion. Chapters on soil conservation deal with a national program of soil conservation, agronomic practices in soil and water conservation, farm and range plants useful for erosion control and water conservation, the place of forestry in soil and water conservation, contouring, terracing, runoff-disposal channel ways and outlets, subsoiling and other subsurface tillage operations, gully prevention and control, control of erosion on highways, small dams for water storage, erosion of stream banks, water spreading, wildlife and soil conservation, soil conservation and flood control, Atlantic and Gulf coastal plain region, Southern Appalachian region, Northern Appalachian and New England area, central prairie and eastern timbered border region, Ozark highlands, the Great Plains, Edwards Plateau – Fort Worth Prairie – Cross Timbers area, Colorado River basin region, Pacific Northwest region, Pacific Southwest region, early efforts toward erosion control, erosion problems in foreign countries, research—an arm of coordinated land use, and soil conservation surveys. McGraw-Hill Book Company, New York, N. Y. $6.00. *(Continued on page 40)*

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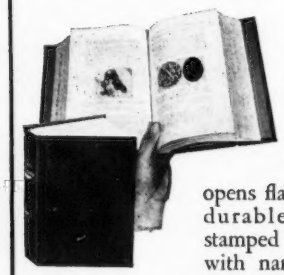

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Literature Received

(Continued from page 38)

PRACTICAL ELECTRICAL WIRING, by H. P. Richter. Cloth bound, VIII+503 pages, 457 illustrations, 18 tables, 5¾x8 in, indexed. A text and reference for students of wiring, covering theory and basic principles of electricity and wiring, residential and farm wiring, and nonresidential wiring such as schools, stores, and factories. Only practices which are in strict accord with the National Electrical Code are recommended and reasons behind methods are explained along with the methods. Chapters cover underwriters and codes, electricity: basic principles and measurements, types of current; power factor; transformers, basic devices and circuits, overcurrent devices, types and sizes of wires, selection of proper wire sizes, wire connections and joints, theory of grounding, outlet and switch boxes, different wiring methods, branch circuits and service entrance, adequacy, good lighting, residential and farm motors, planning an installation, installation of service entrance and ground, installation of specific outlets, finishing: installation switches and other devices, miscellaneous wiring, old work, farm wiring, isolated lighting plants, wiring apartment houses, planning nonresidential installations, miscellaneous problems in nonresidential wiring, nonresidential lighting, wiring for motors, wiring schools and churches, wiring offices, wiring stores, and wiring miscellaneous occupancies. An appendix gives code tables. McGraw-Hill Book Co., New York, N. Y. $3.00.

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

ASSISTANT AGRICULTURAL ENGINEER with farm experience and good basic engineering and agricultural training wanted for work with missionary college in India. Young, adaptable man preferred. Must have missionary purpose as well as technical training. Minimum technical qualification is bachelor of science degree in agricultural engineering. Master's degree highly desirable. Appointee without advanced degree must expect to get it during first furlough. General interest in all phases of agricultural engineering preferred to high degree of specialization. Duties mainly teaching. Ability to cooperate with other members of staff, and to use English language correctly is important. Interested persons should apply to the Candidate Department, Board of Foreign Missions, 156 Fifth Ave., New York City.

POSITIONS WANTED

AGRICULTURAL ENGINEER, with B. S. degree from Rutgers University (1937) and M. S. degree from Virginia Polytechnic Institute (1939) possessing diversified agricultural engineering training, with a major in farm power and machinery, desires employment in institutional instructional, research, or extension work, or with commercial concern, in any branch of agricultural engineering. Age 24. Health excellent—no defects. Single. Rural background. Complete credentials furnished upon request. Best of references. PW-311

AGRICULTURAL ENGINEER with bachelor's degree and a farm background desires supervisional, sales, education, or demonstration work. Has one year's experience with the sales and service branch of a large farm machinery company, and four years' experience as assistant county agent in soil conservation and engineer in charge of a large terracing unit. Has had considerable experience in contacting farmers and helping to solve their problems. Has a real sales record. PW-314

AGRICULTURAL ENGINEER with B. Sc. degree from Virginia Polytechnic Institute, class 1928. Age 35. Health excellent. Single. Farm background. Could go to any location. Have completed the rural electrification sales training course with General Electric Company. Diversified agricultural engineering training, with 11 years' experience in employment of commercial concern in development of rural electrification. Desires employment with farm machinery, or utility company, or any branch of agricultural engineering extension work. Complete information and references furnished upon request. PW-315